INTERNATIONAL CONFERENCE ON APPLIED MATHEMATICS AND NUMERICAL METHODS

Fourth Edition

Craiova, June 29–July 2, 2022

Contents

Welcome to the fourth ICAMNM 2022

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

We continue our series of ICAMNM conferences with an online event due to a decision made by our university at the beginning of this academic year, that is, to put safety above all. However, the quality of 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.

The program of the conference consists of invited talks given in plenary sessions, and presentations scheduled in the following sections of the conference:

- Differential Equations, Dynamical Systems, and Their Applications;
- Applied Mathematics, Numerical Methods and Geometry.

This book contains the abstracts of the presenters' contributions.

We would like to address special thanks to the members of the Scientific Committee who agreed to endorse all papers that will be presented.

Also, we acknowledge the involvement of the Board of the University of Craiova in the organization of the conference.

We wish to all the participants a successful joint work !

The Organizing Committee

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71. Șerban VLAD, Oradea City Hall, Oradea, Romania
72. Cristian VLADIMIRESCU, University of Craiova, Romania
73. Mesfin WOLDAREGAY, Department of Applied Mathematics, Adama Science and Technology University, Adama, Ethiopia

Technical Program

Wednesday, June 29

9:10-9:15 Opening Ceremony

9:15-12:00 Plenary Lectures

Chairman Dana CONSTANTINESCU

9:15-9:55 **Mircea SOFONEA**, *A differential variational inequality in the study of contact problems with wear*

9:55-10:35 **Florica CÎRSTEA**, *Anisotropic elliptic equations with gradient-dependent lower order terms and L^1 data*

10:35-10:40 Break

10:40-11:20 **Higinio RAMOS CALLE**, *Strategies for solving PDEs using the Method of Lines and block methods*

11:20-12:00 **Gabriel PRĂJITURĂ**, *Dynamical sampling*

12:00-15:00 Break

15:00-17:00 Lectures on Sections

Section 1. Differential Equations, Dynamical Systems, and Their Applications

Chairman Cristian DĂNEŢ

15:00-15:20 **Cristian ENACHE**, *Free boundary problems - the maximum principle approach*

15:20-15:40 **Maria FĂRCĂŞEANU**, *Classification of singular solutions to nonlinear elliptic equations with a gradient term*

15:40-16:00 **Andrei GRECU**, *4-Harmonic functions and beyond*

16:00-16:20 **Nicuşor COSTEA**, *Systems of variational inequalities with nonlinear coupling functions*

16:20-16:40 **Cristian CAZACU**, *Hardy inequalities for magnetic p-Laplacians*

16:40-17:00 **Nicoleta Corina BABALÎC**, *The generalized semidiscrete cmKdV system and the periodic reduction*

Section 2. Applied Mathematics, Numerical Methods, Algebra & Geometry

Chairman Adela IONESCU

15:00-15:20 **Renata BUNOIU**, *On the Bingham flow in a thin Y-like shaped structure*

15:20-15:40 **Raluca EFREM**, *Dynamical analysis of a modified SEIR model*

15:40-16:00 **Flavia-Corina MITROI-SYMEONIDIS**, *Redistributing algorithms and Shannon's Entropy: how much we redistribute ?*

16:00-16:20 **Daniel CÎRSTEA**, *Optimized use of Wavelet Packet Trees for the analysis of electrical waveforms*

16:20-16:40 **Dusan KOSTIC**, *Comparison of commercial and original methods for denoising electrical waveforms with constant or linearly variable magnitudes*

16:40-17:00 **Florian MUNTEANU**, *About the Jacobi stability of the Rosenzweig-MacArthur prey-predator system*

17:00-17:15 Break

17:15-19:15 Plenary Lectures

Chairman Magdalena BOUREANU

17:15-17:55 **Mario LEFEBVRE**, *Optimal control of compound Poisson processes*

17:55-18:35 **Magdalena TODA**, *Willmore-type energies and applications to Biophysics*

18:35-19:15 **Nicolae ŢARFULEA**, *Nonlinear differential equations from the Hamiltonian constraint conformal decomposition in general relativity*

Thursday, June 30

9:00-12:30 Plenary Lectures

Chairman Paul POPESCU

9:00-9:40 **Claudia TIMOFTE**, *Homogenization results for diffusion problems in thin periodic media*

9:40-10:20 **Vladimir BALAN**, *On spectral data and tensor decompositions in anisotropic framework*

10:20-11:00 **Ismail Naci CANGUL**, *Graphs and Omega Invariant*

11:00-11:10 Break

11:10-11:50 **Mihai MIHĂILESCU**, *Monotonicity properties for the variational Dirichlet eigenvalues of the p-Laplace operator*

11:50-12:30 **Ana Margarida RIBEIRO**, *On the convexity notions related to lower semi-continuity of supremal functionals*

12:30-15:00 Break

15:00-18:30 Lectures on Sections

Section 1. Differential Equations, Dynamical Systems, and Their Applications

15:00-16:40

Chairman Raluca EFREM

15:00-15:20 **Dumitru COZMA**, *Center conditions for a cubic differential system having a straight line and a cubic curve invariants*

15:20-15:40 **Vadim REPEŞCO**, *The quintic systems with the invariant line at the infinity of maximal multiplicity*

15:40-16:00 **Galina RUSU**, *Limits of solutions to the semilinear plate equation with small parameter*

16:00-16:20 **Ani TUMANYAN**, *Fredholm property of regular hypoelliptic operators on the scales of multianisotropic spaces*

16:20-16:40 **Amel HIOUAL**, *On incommensurate discrete-time fractional-order neural networks*

16:40-16:50 Break

16:50-18:10

Chairman Nicoleta Corina BABALÎC

16:50-17:10 **Mădălina OSICEANU**, *Weak solvability via bipotentials for a class of contact models*

17:10-17:30 **Şerban VLAD**, *Defining the speed independence of the Boolean asynchronous systems*

17:30-17:50 **Aurel DIAMANDESCU**, *On the Ψ-asymptotic equivalence of matrix differential equations of Lyapunov type with modified argument*

17:50-18:10 **Aurel DIAMANDESCU**, *On the Ψ-uniform asymptotic stability of some matrix differential equations of Lyapunov type*

18:10-18:30 **Eduard MUSAFIROV**, *3D Quadratic ODE systems with an infinite number of limit cycles*

Section 2. Applied Mathematics, Numerical Methods, Algebra & Geometry

15:00-16:40

Chairman Galina RUSU

15:00-15:20 **Cristian LĂZUREANU**, *Symmetries and dynamical properties of a class of jerk equations*

15:20-15:40 **Dana CONSTANTINESCU**, *The study of the bifurcations of some 3D dynamical systems with applications in Physics and Ecology*

15:40-16:00 **Mohammad ILIYAS**, *Approximation of Lebesgue integrable functions by Bernstein-Lototsky-Kantorovich operators*

16:00-16:20 **Nicolas BACAËR**, *Mathematical models in epidemiology*

16:20-16:40 **Adela IONESCU**, *On the possible linearization for the dynamics of immunogenic tumors' mathematical model*

16:40-16:50 Break

16:50-18:30

Chairman Dumitru COZMA

16:50-17:10 **Liliana BUCUR**, *The behavior of an epidemiological model*

17:10-17:30 **Mihaela STERPU**, *Study of a 3D system modeling tumor immunotherapy*

17:30-17:50 **Vicenţiu PAŞOL**, *Magnetic quasi-modular form*

17:50-18:10 **Paul POPESCU**, *A non-trivial construction of a Lie pseudoalgebra*

18:10-18:30 **Mesfin WOLDAREGAY**, *Fitted mesh exact difference method for solution of singularly perturbed time delay parabolic PDEs*

Friday, July 1

9:00-11:10 Plenary Lectures

Chairman Florian MUNTEANU

9:00-9:40 **Stelian ION**, *Mathematical modeling of some hydrological processes*

9:40-10:20 **Benedetta NORIS**, *Eigenvalues of the Laplacian with moving mixed boundary conditions*

10:20-11:00 **Loredana BĂLILESCU**, *Bloch waves homogenization in a non-periodic class of microstructures*

11:00-11:40 **Marin MARIN**, *On the existence and uniqueness of generalized solutions for micropolar media with voids*

11:40-11:50 Break

11:50-13:00 Commemorative Section Mitrofan CHOBAN

13:00-15:00 Break

15:00-17:10 Lectures on Sections

Section 1. Differential Equations, Dynamical Systems, and Their Applications

15:00-16:00

Chairman Luminiţa GRECU

15:00-15:20 **Liviu IGNAT**, *Asymptotic behavior of solutions for some local and nonlocal diffusion problems on metric graphs*

15:20-15:40 **Denisa STANCU-DUMITRU**, *Torsional creep problems involving Grushin-type operators*

15:40-16:00 **Cristian VLADIMIRESCU**, *Large time behavior of solutions to a system of coupled nonlinear oscillators via a generalized form of the Schauder-Tychonoff fixed point theorem*

16:00-16:10 Break

16:10-17:10

Chairman Mihaela STERPU

16:10-16:30 **Cristian DĂNEŢ**, *Existence, uniqueness and a maximum principle for a class of hinged plate equations*

16:30-16:50 **George POPESCU**, *Fixed point theorems applied to invariant subspaces problem on Hilbert spaces*

16:50-17:10 **Aurora-Mihaela MARICA**, *Observability inequalities for the wave equation*

Section 2. Applied Mathematics, Numerical Methods, Algebra & Geometry

15:00-17:10

Chairman Laurenţiu TEMEREANCĂ

15:00-15:20 **Süleyman CENGIZCI**, *Stabilized finite element solutions of convection-dominated time-fractional PDEs*

15:20-15:40 **Cătălin ŞTERBEŢI**, *On some interesting techniques used for solving integrals*

15:40-16:00 **Ariana GĂINĂ**, *Dynamics of a four-dimensional economic model with control*

16:00-16:10 Break

16:10-16:30 **Luminiţa GRECU**, *Meshless methods for solving the singular boundary integral equation of the compressible fluid flow around obstacles*

16:30-16:50 **Dana FICUŢ-VICAS**, *A review on the role of basic sciences in sustainable development*

16:50-17:10 **Dumitru BĂLĂ**, *Mathematical models. Applications in Economics and Technology*

17:15 Closing Ceremony

On spectral data and tensor decompositions in anisotropic framework

Vladimir BALAN

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Abstract. The extensions of the Riemannian structure include the Finslerian one, which provided in recent years successful models in various fields like Biology, Physics, GTR, Monolayer Nanotechnology and Geometry of Big Data. The present talk provides basic notions on tensor spectral data and on the HO-SVD and the Candecomp tensor decompositions, and further study several aspects related to the spectral theory of the main symmetric Finsler tensors, the fundamental and the Cartan tensor. In particular, are addressed two Finsler models used in Langmuir Nanotechnology and in Oncology. The HO-SVD and the Candecomp decompositions are exemplified for these models and metric extensions of the eigenproblem are proposed.

AMS Subject Classification (2010): 65F30; 15A18; 15A69; 53B40; 53C60.
Key words: pseudo-Finsler structure, symmetric tensors, spectral data, Cartan tensor, HO-SVD decomposition, Candecomp approximation.

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Bloch waves homogenization in a non-periodic class of microstructures

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Abstract. A first set of macro coefficients known as the homogenized coefficients appear in the homogenization of PDE on periodic structures. If energy is increased or scale is decreased, these coefficients do not provide adequate approximation. Using Bloch decomposition, it is first realized that the above

coefficients correspond to the lowest energy and the largest scale. This naturally paves the way to introduce other sets of macro coefficients corresponding to higher energies and lower scales which yield better approximation.

In this talk, we introduce this macroscopic quantity, namely the dispersion tensor or the Burnett coefficients in the class of periodic media, as well as in the generalized Hashin–Shtrikman microstructures and we study the dependence of the fourth-order tensor in terms of the microstructure. We first review the results in periodic media, where we deal with the one-dimensional case and also some structures in higher dimension. Then, in the case of two-phase materials associated with the periodic Hashin–Shtrikman structures, we settle the issue that the dispersion tensor has a unique minimizer, which is the so called Apollonian–Hashin–Shtrikman microstructure.

References

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Graphs and Omega Invariant

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Abstract. Recently defined as a useful alternative to Euler characteristic of a given graph, the omega invariant of a graph was introduced four years ago to determine several combinatoric, algebraic and topological properties of all realizations of a given degree sequence or of any particular graph. It is very much related to the Euler characteristic and the cyclomatic number. Here, we shall recall some recent results as a brief survey of what is done so far on omega invariant.

AMS Subject Classification (2020): 05C07, 05C30.
Key words: omega invariant; degree sequence; realizability.

Anisotropic elliptic equations with gradient-dependent lower order terms and L^1 data

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Abstract. For every summable function f, we prove the existence of a weak solution for a general class of Dirichlet anisotropic elliptic problems in a bounded open subset Ω of $\mathbb{R}^N$. The principal part is a divergence-form nonlinear anisotropic operator $\mathcal{A}$, the prototype of which is $\mathcal{A}u = -\sum_{j=1}^N \partial_j(|\partial_j u|^{p_j-2}\partial_j u)$ with $p_j > 1$ for all $1 \le j \le N$ and $\sum_{j=1}^N (1/p_j) > 1$. As a novelty, our lower order terms involve a new class of operators $\mathfrak{B}$ such that $\mathcal{A} - \mathfrak{B}$ is bounded, coercive and pseudo-monotone from $W_0^{1,\overrightarrow{p}}(\Omega)$ into its

dual, as well as a gradient-dependent nonlinearity with an "anisotropic natural growth" in the gradient and a good sign condition.

This is joint work with Barbara Brandolini (Università degli Studi di Palermo, Italy).

Mathematical modeling of some hydrological processes

Stelian ION, Dorin MARINESCU, and Ştefan-Gicu CRUCEANU

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Abstract. In this talk we focus on the water flow and soil erosion on a plant cover soil surface. Soil erosion is a complex and hardly measurable process. Its complexity is mostly due to a multitude of factors which contribute to sediment particle entrainment and transport in water. The presence of vegetation further complicates the problem since the aerial part of the plants has influence on the water flow dynamics, and the roots modify the physico-chemical properties of the soil. Modeling at a catchment scale involves variations in the physico-mechanical properties of the soil, in its topography, as well as in its plant cover structure. We analyze a mathematical model given by Saint-Venant equations coupled with the multiple particle class Hairsine-Rose soil erosion model.

Optimal control of compound Poisson processes

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Abstract. The problem of controlling a compound Poisson process until it leaves an interval is considered. This type of problem is known as a homing problem. To determine the value of the optimal control, we must solve a non-linear integro-differential equation. Exact and explicit solutions are obtained for two possible jumps size distributions.

On the existence and uniqueness of generalized solutions for micropolar media with voids

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Abstract. In our study we adapt certain basic results from the abstract theory of differential equations of the elliptic type with the purpose to deduce some basic results in the case of a concrete type of media. Namely, after the mixed initial-boundary values problem is formulated in the context of elasticity of Cosserat bodies with voids, some results on existence of a generalized solution are proven. The uniqueness of this solution is also proven.

AMS Subject Classification (2010): 34D20, 37C20, 37C75, 53E10
Key words: predator–prey systems, Kolmogorov systems, Jacobi stability, KCC-theory.

References

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Monotonicity properties for the variational Dirichlet eigenvalues of the p-Laplace operator

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Abstract. Let $D \geq 2$ be an integer. For each open and bounded set $\Omega \subset \mathbb{R}^D$ and each integer $k \geq 1$ we denote by $R_k(\Omega)$ the largest number $r > 0$ for which there exists k disjoint open balls in Ω of radius r. Next, for each open, bounded, convex set $\Omega \subset \mathbb{R}^D$ with smooth boundary and each real number $p \in (1, \infty)$ we denote by $\{\lambda_k(p; \Omega)\}_{k \geq 1}$ the sequence of eigenvalues of the p-Laplace operator subject to the homogeneous Dirichlet boundary conditions, given by the Ljusternik-Schnirelman theory. For each integer $k \geq 1$ we show that there exists $M_k \in [(ke)^{-1}, 1]$ such that for any open, bounded, convex set $\Omega \subset \mathbb{R}^D$ with smooth boundary for which $R_k(\Omega)$ is less than or equal to M_k, the k-th eigenvalue of the p-Laplacian on Ω, $\lambda_k(p; \Omega)$, is an increasing function of p on $(1, \infty)$. Moreover, there exists $N_k \geq M_k$ such that for any real number $s \in (N_k, \infty) \setminus \{1\}$ there exists an open, bounded, convex set $\Omega \subset \mathbb{R}^D$ with smooth boundary which has $R_k(\Omega)$ equal to s such that $\lambda_k(p; \Omega)$ is not a monotone function of $p \in (1, \infty)$.

Eigenvalues of the Laplacian with moving mixed boundary conditions

Benedetta NORIS

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Abstract. I shall present some results obtained in collaboration with V. Felli and R. Ognibene, concerning eigenvalue problems for the Laplacian in bounded domains with varying mixed boundary conditions. We deal both with the case of homogeneous Dirichlet conditions on a vanishing portion of the boundary and Neumann conditions on the complement, and with the opposite case.

Dynamical sampling
Gabriel PRĂJITURĂ

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Abstract. When we have some event that happens accidentally we are rarely able to see what triggered it. We only start measuring after a while from the incident and we can keep measuring. The problem is how to determine the initial value from the data measured later. The model of this situation is with the initial event being some vector in a Hilbert space, and the changing in time being encoded by the action of some linear operator. The measurements are done from the direction of some vector y.

In mathematical terms, what we have is $< Tx, y >$; $< T^2x, y >$; $< T^3x, y >$; ... so we have the inner products of the iterates of x under T with y. The problem is how to recover x from these values. This problem is called dynamical sampling and it is very important in engineering applications as well as in data analysis (via reproducing kernel Hilbert spaces).

We will present an introduction into dynamical sampling and discuss some of the current issues and open problems.

Strategies for solving PDEs using the Method of Lines and block methods
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Abstract. Recently, block methods have been widely used to get approximate solutions of different types of differential problems. They share ideas with classical methods such as multi-step linear methods or Runge-Kutta methods. The first known reference to these methods dates back to W. E. Milne, in a work dated 1953 (Numerical Solution of Differential Equations, John Wiley and Sons). A block method consists of a series of formulas that provides an approximate solution to a differential problem at more than one point at a time. Our goal is to use the block methods to solve partial differential equations. To do this we first have to discretize the PDE using the method of lines taking into account appropriate initial and boundary conditions. We will illustrate how to obtain such a semi discretized problem and how to use a block method to get a numerical solution. In particular, we will illustrate its use to efficiently solve the Buckmaster equation, a nonlinear equation that models the surface of a thin sheet of viscous liquid, or diffusion equations, or Burgers equations, among others.

On the convexity notions related to lower semi-continuity of supremal functionals
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Abstract. When studying the minimization of supremal functionals of the form

$$F(u) := \operatorname*{ess\,sup}_{x\in\Omega} f(Du(x)), \text{ for } u \in u_0 + W_0^{1,\infty}(\Omega; \mathbb{R}^N)$$

several concepts of convexity come into play. We revisit these concepts in order to clarify the relations between them answering, also, to some elementary questions with nontrivial answers.

This is a joint work with Elvira Zappale.

A differential variational inequality in the study of contact problems with wear

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Abstract. We start with a mathematical model which describes the sliding contact of a viscoelastic body with a moving foundation. The contact is frictional and the wear of the contact surfaces is taken into account. We prove that this model leads to a differential variational inequality in which the unknowns are the displacement field and the wear function. Then, inspired by this model, we consider a general differential variational inequality in reflexive Banach spaces, governed by four parameters. We prove the unique solvability of the inequality as well as the continuous dependence of its solution with respect to the parameters. The proofs are based on arguments of monotonicity, compactness, convex analysis and lower semicontinuity. We apply these abstract results to the mathematical model of contact for which we deduce the existence of a unique solution as well as the existence of optimal control for an associate optimal control problem. We also present the corresponding mechanical interpretations.

Nonlinear differential equations from the Hamiltonian constraint conformal decomposition in general relativity

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Abstract. In this talk, a class of nonlinear elliptic equations with nonlinear boundary conditions in exterior domains is addressed. Problems of this type arise in many different contexts. An application related to the initial data problem in general relativity is presented.

Homogenization results for diffusion problems in thin periodic media

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Abstract. In this talk, we shall present some recent homogenization results for diffusion problems in a thin periodic composite medium made up of two materials, having different features and being separated by an imperfect interface. Across this interface, we suppose that the solution of the problem under study and its flux can exhibit jumps. We consider various forms for the functions describing the jumps involved in our microscopic problem. By using suitable unfolding operators, adapted to thin domains and allowing us to simultaneously perform homogenization and dimension reduction, we obtain several macroscopic models and we compare them with the existing ones in the literature. Our mathematical setting might be relevant for the analysis of various filtering materials, such as textiles, paper, or biological tissues.

AMS Subject Classification (2010): 376A20, 76S05, 74A50, 76M45.
Key words: thin periodic domain, imperfect interfaces, homogenization methods.

Willmore-type energies and applications to Biophysics

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Abstract. This study focuses on the theory and applications of curvature functionals for submanifolds, which we refer to as elastic energies or generalized Willmore energies. Biological applications include protein folding, red blood cells and biomembranes. We present recently published and unpublished results on critical points of these energies, stability, and related generalized Willmore flows. Cases of generalized Willmore surfaces with fixed and free boundaries will also be presented if time permits.

Algebra, Geometry and Applications

A non-trivial construction of a Lie pseudoalgebra

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Abstract. The aim of the talk is to construct a Lie pseudoalgebra on the derived almost Lie module $M^{(1)}$ of an almost Lie module M. The construction applies when some extended curvatures on M, considered in the paper, are vanishing. Some non-trivial examples show that the result is non-trivisl and also the setting is not resumed to the case when M is a skew symmetric Lie module.

Applied Mathematics in Physics, Engineering, Economics, Medicine, Biology

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 Lyapunov 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 Lyapunov function in case of dynamic systems in which we analyze stability.

Mathematical models in epidemiology

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Abstract. Some results on the date of the epidemic peak are presented in fairly simple mathematical models. Approximate formulas are obtained when the population size is large.

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On the Bingham flow in a thin Y-like shaped structure

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Abstract. We consider the steady Bingham flow in a two-dimensional thin Y-like shaped structure, with no-slip boundary conditions and under the action of given external forces. After passage to the limit with respect to a small parameter related to the thickness of the domain, we obtain three uncoupled problems. Each of these problems describes an anisotropic flow, corresponding to a lower-dimensional ”Bingham-like” constitutive law. These results are in accordance with the engineering models.

This is a joint work with Antonio Gaudiello (University of Campania ”Luigi Vanvitelli”, Italy).

Stabilized finite element solutions of convection-dominated time-fractional PDEs

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Abstract. In this presentation, we deal with the stabilized solutions of convection-dominated problems having time-fractional derivatives in the Caputo sense. It is a well-known fact that the classical methods are insufficient to tackle convection-dominated problems accurately, and special computational techniques are required. Therefore, spatial discretization is performed by employing the streamline-upwind/Petrov-–Galerkin formulation. The semi-discrete formulation is further supplemented with a shock-capturing term to obtain better shock representations near steep gradients. The time-fractional derivatives are approximated by using a numerical scheme based on finite differences. Three test computations are provided to evaluate the capability of the stabilized formulation and shock-capturing term. It is observed that spurious oscillations are almost completely eliminated by using the proposed techniques.

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The study of the bifurcations of some 3D dynamical systems with applications in physics and ecology

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Abstract. The classical bifurcations that occur in some 3D dynamical systems of practical interest (physics, ecology) are presented, but our attention is focused on the case when the systems have in infinite number of periodic points at the bifurcation limit. The dynamics of each system is analyzed and the results are interpreted from a practical point of view.

AMS Subject Classification (2010): 34D20, 37C20, 37C75, 53E10
Key words: predator–prey systems, Kolmogorov systems, Jacobi stability, KCC-theory.

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Dynamical analysis of a modified SEIR epidemic mdel

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Abstract. The aim of this work is to study qualitative dynamical properties of an generalized SEIR model. The basic reproduction number which determines the disease's extinction or continued existence is obtained. Asymptotic stability properties of the model are analyzed.

Key words: Epidemic models; non-linear incidence; removal rate; basic reproductive number.

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A review on the role of basic sciences in sustainable development

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Abstract. Over the course of history, Basic Sciences such as Mathematics, Astronomy, Physics, Biology, Chemistry, etc. were the drivers of economical development through the multiple applications of the new discoveries in each and every area of scientific research mentioned above. Today, Basic Sciences are called upon to support sustainable development, to contribute to making the world better, protecting our planet and improving the life of humans all over the world. Is this indeed a new task for Basic Sciences? To celebrate the International Year of Basic Sciences for Sustainable Development 2022, I invite you to take a journey and find out the role Basic Sciences play in Sustainable Development. Our daily life throws at us complex problems that are rarely mono-disciplinary, hence we are constantly successfully applying our knowledge outside our field of expertise. Who wouldn't want to save the world by solving an open question in Mathematics? Actually, when you think of the implications and the applications of your research results you might find out that you are contributing already to Sustainable Development or at least you could.

Approximation of Lebesgue integrable functions by Bernstein–Lototsky–Kantorovich operators

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Abstract. In this paper generalized Kantorovich operators are constructed using Lototsky–Bernstein basis functions on unit interval. Approximation of continuous functions by these sequence of operators has been established based on Korovkin's theorem. It has been shown that this sequence of generalized Kantorovich operators converges to function f belonging to the class $L^p[0,1](p \geq 1)$ too.

AMS Subject Classification (2010): 41A35, 41A36, 41A65.
Key words: Lototsky-Bernstein bases; Lebesgue integrable function; $(C, 1)$ transform.

On the possible linearization for the dynamics of immunogenic tumors' mathematical model

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Abstract. The task of mathematical modeling the cancer is a monumental challenge. Past and current mathematical models have been proposed to examine the tumor growth and the discussions and challenges still remain. The present paper concerns with a basic model proposed by Kuznetsov, Makalkin and Taylor for immunogenic tumors. A lot of analyses were done for this model, both in 2d and 3d case. It is known that in these type of models, the parameters influence and estimation is extremely important. In this paper another standpoint is taken into account. Namely, the existence of a state space exact linearization for the dynamics of the model is approached. The basic 2d case is tested for the moment. The important result is that the 2d model admits a state space exact linearization, in feasible conditions for the parameters. Moreover, the control u involved in the method can have a graphical (implicit) evaluation, based on some parameters values from the literature and experiments. This evaluation would be useful in further analysis, together with the extension to the 3d model.

AMS Subject Classification (2010): 93C40, 93C15, 93D15, 93B18, 92C60
Key words: immunogenic tumor, non-linear control system, state space linearization, linear controllable system.

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Comparison of commercial and original methods for denoising electrical waveforms with constant or linearly variable magnitudes

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Abstract. Acquired electrical waveforms can be affected by white noise. The 1-st part of the paper analysis deals with the denoising of multi-period steady signals by using 3 methods: mean signal method, an original method relying on wavelet packet trees and the method implemented by the wavelet-based Matlab function wden. The signal length influence over the mean signal method's accuracy is studied.

The results yielded by the other 2 methods are also analyzed considering signals with 7 periods. Afterward the wavelet-based methods are used to denoise segments of 7 periods with linearly variable magnitudes (ascending or descending) for 3 different slopes. Artificial test signals, with rich harmonic content, were used. They were polluted by sets of 10 white noises with different powers. Maximum absolute deviations and mean square root deviations were computed considering the original signals, before pollution, versus the corresponding denoised signal. The metrics were computed relative to the maximum absolute value of the noise and allowed to determine the most accurate method.

Key words: Wavelet Packet Transform, Noise measurement, White Noise, Computer aided analysis.

Symmetries and dynamical properties of a class of jerk equations

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Abstract. In this paper, we consider the following class of jerk equations

(1) $$\dddot{x} + \beta\ddot{x} + V''(x)\dot{x} = f_\mu(x),\ \ \beta > 0, \mu \in \mathbb{R},$$

which is deduced from the differential equation describing a particle in some potential $V = V(x)$. Using functions V and f_μ such that equation (1) exhibits some symmetries, dynamical properties of this equation are pointed out.

Redistributing algorithms and Shannon's Entropy: how much we redistribute ?

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Abstract. Since there is no universal formula for the entropy, the existing literature deals with a variety of formulas which are adequate for specific phenomena but not relevant for others. The main difficulty is to establish algorithms for a given phenomenon, in order to determine the underlying probabilities associated to the collected raw data. Such algorithms exist for time series, however the nature of the process under consideration matters and they might lead to different interpretations. In this framework we investigate how Shannon's entropy changes when the distribution probability is modified by means of redistributing algorithms.

AMS Subject Classification (2010): Primary 94A17; Secondary 37M10, 37A35.
Key words: permutation entropy; time series analysis; redistributing algorithms.

Optimized use of Wavelet Packet Trees for the analysis of electrical waveforms

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Abstract. — Wavelet packet trees represent a topic which grows in popularity when it comes to analysis of electrical waveforms. It allows for time-frequency analysis providing information on narrower ranges of frequency (as compared to the faster Discrete Wavelet Decomposition), but the computational resources are significantly greater than that involved in other types of wavelet-based analysis. In order to allow for this type of analysis to be usable in real-time applications, that is – to reduce the runtime, original algorithms were conceived and tested.

Weak solvability via bipotentials for a class of contact models

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Abstract. We consider two mathematical models which describe the contact between a body and a foundation. The behavior of the materials is modeled by a constitutive law which is described by means of the subdifferential of a convex map. For each model, we propose a variational formulation in terms of bipotentials, whose unknown is a pair consisting of the displacement field and the Cauchy stress tensor. The solutions are sought into product spaces involving variable convex sets. Both models lead to variational systems which can be cast in an abstract setting. After delivering some abstract results, we apply them to the models under consideration in order to study the existence and uniqueness, as well as the data dependence of the weak solutions.

Magnetic quasi-modular form

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Abstract. We expand upon a recent observation of Broadhurst and Zudilin, rigorously accomplished by Li and Neururer that realised the first examples of magnetic quasi-modular forms. We formally define them and prove explicit characterisations. The proofs rely on Shimura-Borcherds lifts and a fine analysis of their associated Hecke operators.

This is a joint work with Wadim Zudilin.

Differential Equations, Dynamical Systems, and Their Applications

The generalized semidiscrete cmKdV system and the periodic reduction

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Abstract. In this paper we show that complete integrability is preserved in a multicomponent semidiscrete complex mKdV system with branched dispersion relation. We use two approaches for this porpose. The first method used is the Hirota bilinear formalism that helps us construct the multisoliton solutions for a system of coupled M equations. The same soliton solutions can be obtained through another approach called the periodic reduction, which has as a starting point a two-dimensional completely integrable generalized cmKdV system.

A general epidemiological model including the effect of social interaction

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Abstract. In this work we consider the next system:

$$\begin{gathered} S\prime = A - \beta\left(1 + \nu I\right) SI \\ E\prime = \beta\left(1 + \nu I\right) SI - \alpha E \\ I\prime = \alpha E - \gamma I \\ R\prime = \gamma I \end{gathered}$$

that means the probability of disease transmission depend linear of the number of infectious. $S(t)$ denoting the number of susceptible individuals, $E(t)$ the number of exposed individuals (were the individuals are infected but not infectious), $I(t)$ the number of infectious individuals $R(t)$ the number of recovered individuals. The parameters are defined as: A per-capita birth rate, α rate of progression from exposed to infectious (the reciprocal is the incubation period), β probability of disease transmission per contact times the number of contacts per unit time, γ recovery rate of infectious individuals (the reciprocal is the infectious period) μ per-capita natural death rate.
We will find the equilibrium points and will study their stability. Also we will study the next system:

$$\begin{gathered} S\prime = A - \beta\left(1 + \nu I^2\right) SI \\ E\prime = \beta\left(1 + \nu I^2\right) SI - \alpha E \\ I\prime = \alpha E - \gamma I \\ R\prime = \gamma I \end{gathered}$$

that means the probability of disease transmission depend of two degree polynomial of the number of infectious.

Hardy inequalities for magnetic p-Laplacians

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Abstract. Improved Hardy inequalities for the p-Laplacian due to adding magnetic fields are established, while other expected results are stated as conjectures. Some general L^p magnetic-free Hardy inequalities in the spirit of Allegretto and Huang [Nonlinear Anal. 32 (1998)] are also considered.

This exposure is based on a joint work with David Krejčiřík (Czech Technical University, Prague) and Ari Laptev (Imperial College London).

This talk is partially supported by CNCS-UEFISCDI Romania, Grant No. PN-III-P1-1.1-TE-2021-1539.

Systems of variational inequalities with nonlinear coupling functions

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Abstract. In this talk the existence of solutions for a system consisting of two inequalities of variational type is discussed. Each inequality is formulated in terms of a nonlinear bifunction χ and ψ, respectively and a coupling functional B. More precisely, we seek $u \in K \subseteq X$ and $\lambda \in \Lambda \subseteq Y$ such that

$$(S): \begin{cases} B(v,\lambda) - B(u,\lambda) + \chi(u, v-u) \geq \langle f, v-u \rangle, & \forall v \in K, \\ B(u,\lambda) - B(u,\mu) + \psi(\lambda, \mu-\lambda) \geq \langle g, \mu-\lambda \rangle, & \forall \mu \in \Lambda, \end{cases}$$

with X, Y real reflexive Banach spaces, $B : X \times Y \to \mathbb{R}$, $\chi : X \times X \to \mathbb{R}$, $f \in X^*$, $\psi : Y \times Y \to \mathbb{R}$ and $g \in Y^*$.

We consider two sets of assumptions $(\mathbf{H}^{\mathbf{i}}_{\chi})$, $(\mathbf{H}^{\mathbf{j}}_{\psi})$ and $(\mathbf{H}^{\mathbf{k}}_{\mathbf{B}})$, $i, j, k \in \{1, 2\}$ and we show that, if the constraints sets K and Λ are bounded, closed and convex, then a solution exists regardless if we assumed the first or the second hypothesis on χ, ψ or B, thus obtaining eight possibilities.

When either K or Λ is unbounded a coercivity condition is needed to ensure the existence of solutions. We provide two such conditions $(\mathbf{C_1})$ and $(\mathbf{C_2})$, respectively. The main result states that if either $(\mathbf{C_1})$, $(\mathbf{H}^{\mathbf{1}}_{\mathbf{B}})$, $(\mathbf{H}^{\mathbf{j}}_{\chi})$, $(\mathbf{H}^{\mathbf{k}}_{\psi})$, or $(\mathbf{C_2})$, $(\mathbf{H}^{\mathbf{i}}_{\mathbf{B}})$, $(\mathbf{H}^{\mathbf{j}}_{\chi})$, $(\mathbf{H}^{\mathbf{k}}_{\psi})$ hold with $i, j, k \in \{1, 2\}$, then (S) possesses at least one solution.

This presentation is partially supported by CNCS-UEFISCDI Grant No. PN-III-P1-1.1-TE-2019-0456.

Center conditions for a cubic differential system having a straight line and a cubic curve invariants

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Abstract. We consider real cubic differential systems 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 $p_j(x,y)$ and $q_j(x,y)$, $j \in \{2,\ 3\}$ are homogeneous polynomials of degree j. 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 problem of the center) is open for general cubic systems.

The problem of the center was solved for some subclasses of cubic systems (1) with algebraic solutions: four and three invariant straight lines in [1-3]; two invariant straight lines and one invariant conic in [2]; two invariant straight lines and one invariant cubic in [4]; two parallel invariant straight lines in [5],[6].

In this talk we consider the following problems:

(i) determine the subclass of cubic differential systems (1) which has an invariant straight line and an invariant cubic curve;

(ii) for this subclass find the conditions under which the origin is a center.

AMS Subject Classification (2010): 34D20, 37C20, 37C75, 53E10
Key words: predator–prey systems, Kolmogorov systems, Jacobi stability, KCC-theory.

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Existence, uniqueness and a maximum principle for a class of hinged plate equations

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Abstract. This paper is concerned with the problem of existence and uniqueness of solutions for a fourth order boundary value problem that models the deflection of a hinged plate of constant and nonconstant flexural rigidity. Although, fourth order equations do not satisfy in general a maximum principle we are able to prove a maximum principle when the plate has a circular shape.

AMS Subject Classification (2010): 35J35, 35J40, 74K20.
Key words: fourth order, plate theory, Kirchhoff-Love.

On the Ψ-asymptotic equivalence of matrix differential equations of Lyapunov type with modified argument

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Abstract. The aim of this work is to give sufficient conditions for the Ψ-asymptotic equivalence of Ψ−bounded solutions of two matrix differential equations of Lyapunov type with modified argument

$$Z' = A(t)Z + ZB(t)$$

$$Z' = A(t)Z + ZB(t) + F(t, Z(g(t))),\ t \geq t_0.$$

These conditions can be specified in terms of fundamental matrices of the matrix differential equations

$$X' = A(t)X,$$

$$Y' = YB(t)$$

and related to the functions F and G.

Here, Ψ is a matrix function which allows to obtaining various asymptotic behaviors of the components of the solutions of the differential equations considered.

The main working tools are a fixed point theorem for strict h-contractions, the variation of constants, the Kronecker product, and the vectorization operator of matrices.

The results obtained extend results from the known literature in three directions: for matrix differential equations, through the using of the function Ψ, and the belonging of the solutions to the spaces L^r.

The bibliography has 13 references.

On the Ψ-uniform asymptotic stability of some matrix differential equations of Lyapunov type

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Abstract. The aim of this work is to give sufficient conditions for the Ψ-uniform asymptotic stability of matrix differential equations of Lyapunov type

$$Z' = A(t)Z + F(t, Z),$$

$$Z' = A(t)Z + ZB(t) + F(t, Z),$$

$$Z' = A(t)Z + ZB(t) + \int_0^t G(t, s, Z(s))ds,$$

which are seen as perturbations of the matrix linear differential equations

$$Z' = A(t)Z,$$

$$Z' = ZB(t),$$

$$Z' = A(t)Z + ZB(t).$$

These conditions can be specified in terms of fundamental matrices of these matrix linear differential equations and related to the elements of the matrices F and G.

Here, Ψ is a matrix function which allows to obtaining various asymptotic behaviors of the components of the solutions of the differential equations considered.

The main working tools are the variation of constants, Gronwall lemma, the Kronecker product, and the vectorization operator of matrices.

The results obtained extend results from the known literature.

The bibliography has 13 references.

Free boundary problems - the maximum principle approach

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Abstract. In a response to a fluid flow query posed by physicists, J. Serrin [Arch. Rational Mech. Anal., 1971] considered the Saint-Venant problem on a bounded domain Ω, together with an overdetermination on the C^2 boundary $\partial\Omega$ ($|Du| =$ const. on $\partial\Omega$) and proved that this free boundary problem has a solution if and only if Ω is a ball. Serrin's proof is based on the moving plane method and maximum principles. Under weaker assumptions on the regularity of Ω, H.F. Weinberger [Arch. Rational Mech. Anal., 1971] presented a simpler proof, which combines a maximum principle for a P-function and a Rellich type identity. Weinberger's inspiring idea was later employed by many other authors in dealing with various free boundary problems. This talk gives a survey of some old and recent results in this directions.

Classification of singular solutions to nonlinear elliptic equations with a gradient term

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Abstract. In this talk, we present recent classification results of the behavior near zero for the positive solutions of some nonlinear elliptic equations with singular potentials and gradient-dependent nonlinearities. This is joint work with Florica Cîrstea. The presentation is partially supported by CNCS-UEFISCDI Grant No. PN-III-P1-1.1-PD-2021-0037 and CNCS-UEFISCDI Grant No. PN-III-P1-1.1-TE-2019-0456.

Dynamics of a four-dimensional economic model with control

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Abstract. In the present paper we investigate the behavior of an economical model based on differential equations with four variables: the real interest rate, the investment demand, the inflation rate and a control function of the system. Transcritical, pitchfork and Hopf bifurcations are obtained in order to understand the behavior of this four-dimensional economic model with control.

4-Harmonic functions and beyond

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Abstract. The family of partial differential equations $-\Delta_4 u - \epsilon\Delta_\infty u = 0$ ($\epsilon > 0$) is studied in a bounded domain Ω for given boundary data. We show that for each $\epsilon > 0$ the problem has a unique viscosity solution which is exactly the $(4 + \epsilon)$-harmonic map with the given boundary data. We also explore the connections between the solutions of these problems and infinity harmonic and 4-harmonic maps by studying the limiting behavior of the solutions as $\epsilon \to \infty$ and $\epsilon \to 0^+$, respectively. This is based on a joint work with Mihai Mihăilescu. The presentation is partially supported by CNCS-UEFISCDI Grant No. PN-III-P1-1.1-TE- 2019-0456.

On incommensurate discrete-time fractional-order neural networks

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Abstract. There is a lack of convincing results addressing the stability analysis of nonlinear incommensurate discrete-time fractional-order neural networks. To address such quandaries, the current study proposes several unique handy criteria that may be used to assure the asymptotic stability of such systems. We intend to propose certain results that aim to reveal the stability of the nonlinear incommensurate fractional-order discrete neural networks system framed in the sense of the Caputo difference operator, in particular using a novel result on the stability of nonlinear incommensurate fractional-order difference systems. The numerical solutions for discrete-time neural networks with incommensurate fractional-orders are shown to be stable, confirming these innovative result.

The proposed incommensurate fractional-order discrete neural network is described by:

$$(2)\qquad \begin{cases} {}^C_a\Delta_t^{v_1} x_1(t) = -a_1 x_1(t+v_1-1) + \sum_{j=1}^n b_{1j} f_j(t+v_1-1, x_j(t+v_1-1)) + I_1, & t \in \mathbb{N}_a, \\ {}^C_a\Delta_t^{v_2} x_2(t) = -a_2 x_2(t+v_2-1) + \sum_{j=1}^n b_{2j} f_j(t+v_2-1, x_j(t+v_2-1)) + I_2, & t \in \mathbb{N}_a, \\ \dots \\ {}^C_a\Delta_t^{v_n} x_n(t) = -a_n x_n(t+v_n-1) + \sum_{j=1}^n b_{nj} f_j(t+v_n-1, x_j(t+v_n-1)) + I_n, & t \in \mathbb{N}_a. \end{cases}$$

(2) can be reduced as

$$(3)\qquad {}^C_a\Delta_t^{\overline{v}} x(t) = -A x_i(t+v_i-1) + Bf(t+v_i-1, x(t+v_i-1)) + I,$$

where $t \in \mathbb{N}_a$, and $\overline{v} = (v_1, v_2, ..., v_n)$, ${}^C_a\Delta_t^{v_i}$ denotes the variable-order fractional Caputo difference operator of order v_i, $x(t) = (x_1(t), ..., x_n(t))^T \in \mathbb{R}^n$ is the state of the unit at time t and n is the dimension, $A = diag(a_1, ..., a_n)$ where $a_i > 0$ represents the matrix with which the neurons will reset its potential to the resting state when desconnected from the network, $B \in \mathbb{R}_{n*n}$ corresponds to the connection weights and finally $f(t, x(t)) \in C(\mathbb{N}_a, \mathbb{R}^n)$ is the activation function.

Using Theorems concerning the stability of fractional-order linear and nonlinear difference system, we provide a novel theorem for the stability of the fractional-order discrete-time neural network which is given by the following.

Theorem. *Suppose that* $0 < v_i < 1$ *for* $i = 1, ..., n$ *and* M *is the lowest common multiple of the denominators* u_i *of* v_i*'s such that* $v_i = \frac{w_i}{u_i}$ *and* $(u_i, w_i) = 1,\ u_i, w_i \in \mathbb{Z}$. *Let* $\alpha = \frac{1}{M}$, *if at least one root of the following equation*

$$det(diag(\lambda^{Mv_1}, \lambda^{Mv_2}, ..., \lambda^{Mv_n}) - (1 - \lambda^M)(-A + BJ)) = 0 \tag{4}$$

lies inside the set $\mathbb{C} \setminus S$, *where* J *is the jacobian matrix of* f *at* 0. *Then, the trivial solution of system* (3) *is locally asymptotically stable corresponding to the initial condition* $x(0) = x_0 \in \mathbb{R}^n$, *where*

$$S = \left\{ z \in \mathbb{C},\ |z| \leq \left(2\cos\frac{|\arg z|}{\alpha} \text{ and } |argz| \leq \frac{\alpha\pi}{2} \right) \right\}.$$

We also present its proof and an example with numerical simulations.

Asymptotic behavior of solutions for some local and nonlocal diffusion problems on metric graphs

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Abstract. In this talk we present some recent result about the long time behavior of the solutions for some diffusion processes on a metric graph. We study local and nonlocal (convolution type problems with an integrable kernel) evolution problems on a metric connected finite graph in which some of the edges have infinity length. We show that the asymptotic behaviour of the solutions is given by the solution of the heat equation, but on a star shaped graph in which there is only one node and as many infinite edges as in the original graph. In this way we obtain that the compact component that consists in all the vertices and all the edges of finite length can be reduced to a single point when looking at the asymptotic behaviour of the solutions. We prove that when time is large the solution behaves like a gaussian profile on the infinite edges. This is a joint work with Julio D. Rossi (Buenos Aires) and Angel San Antolin (Alicante).

Observability inequalities for the wave equation

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Abstract. In this talk, we consider the observability inequality for the wave equation, stating that the total energy of soluțions is comparable to the energy concentrated on the boundary of the domain on which the model is studied, if the observation time is sufficiently large (at least twice the length of the largest characteristic ray going through the domain). For the semidiscrete versions of the wave equation (using finite differences, P1/P2 finite elements or discontinuous Galerkin approximations), the observability inequality does not hold uniformly with respect to the mesh size parameter on uniform grids. In all these discrete cases, we consider the proof of the observability inequality based on multipliers and construct classes of non-uniform meshes for which the inequality holds uniformly.

About the Jacobi stability of the Rosenzweig–MacArthur prey-predator system

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Abstract. In this talk, we consider an autonomous two-dimensional ODE Kolmogorov type system with three parameters, which is a particular system of the general prey-predator systems with a Holling type II. By reformulating this system as a set of two second order differential equations, we investigate the nonlinear dynamics of the system from the Jacobi stability point of view, using the Kosambi-Cartan-Chern geometric theory. It will be determined the five KCC-invariants which express the intrinsic geometric properties of the system, including the deviation curvature tensor. Finally, it will be obtain necessary and sufficient conditions on the parameters of the system in order to have the Jacobi stability near the equilibrium points.

AMS Subject Classification (2010): 34D20, 37C20, 37C75, 53E10.
Key words: predator–prey systems, Kolmogorov systems, Jacobi stability, KCC-theory.

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3D Quadratic ODE systems with an infinite number of limit cycles

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Abstract. We consider an autonomous three-dimensional quadratic ODE system with nine parameters, which is a generalization of the Langford system. We derive conditions under which this system has infinitely many limit cycles. First, we study the equilibrium states of such systems and their eigenvalues. Next, we prove the non-local existence of an infinite set of limit cycles emerging by means of Andronov - Hopf bifurcation. Moreover, for the systems under consideration, we construct a set of non-autonomous admissible (with preservation of the Mironenko reflecting function) perturbed systems of ODEs. Finally, for perturbed systems we obtain conditions for the existence of an infinite number of periodic solutions and investigate their stability.

Key words: Hopf–Langford type system, limit cycle, Andronov - Hopf bifurcation, periodic solution, Mironenko reflecting function.

Fixed point theorems applied to invariant subspaces problem on Hilbert spaces

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Abstract. The main goal of this paper is to raise the general interest for applying fixed point theorems to the invariant subspace problem for bounded operators on separable Hilbert spaces, by finding a proper or new fixed point theorem and a suitable setting, mainly theorems that could produce three fixed points.

The quintic systems with the invariant line at the infinity of maximal multiplicity

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Abstract. Consider the generic quintic differential system

$$\begin{cases} \dot{x} = P\left(x,y\right), \\ \dot{y} = Q\left(x,y\right), \end{cases} \tag{5}$$

where $P, Q \in \mathbb{R}[x, y]$, $\max\{\deg P, \deg Q\} = 5$, $\mathrm{GCD}\,(P, Q) = 1$. A Darboux first integral for any polynomial differential system can be constructed if there are a sufficent number of invariant algebraic curves, see [1]. Moreover, the number and the mulitiplicities of the invariant straight lines can play a significant role in the existence of the limit cycles [2], the center problem [3] and other properties of a polynomial differential system [4]. If $yP_5 - xQ_5 \not\equiv 0$, where P_5 and Q_5 are homogeneous polynomials of degree 5, then the system (5) has at the infinity an invariant straight line of the multiplicity at least one. In [5] it was shown that the maximal algebraic multiplicity of the invariant line at the infinity is at least 13. In this work, algebraically, we obtain three systems with these properties, which, via affine transformations and time rescaling, were brought to the form (6).

$$\begin{cases} \dot{x} = x, \quad a, b \in \mathbb{R}, b \neq 0, \\ \dot{y} = a - 4y + bx^5. \end{cases} \tag{6}$$

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Limits of solutions to the semilinear plate equation with small parameter
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Abstract. Let $\Omega \subset \mathbb{R}^n$ be an open and bounded set with the smooth boundary $\partial\Omega$. Consider the following initial boundary value problem for the plate equation

$$\begin{cases} \varepsilon\, u_{tt}(x,t) + u_t(x,t) + \Delta^2 u(x,t) = f(x,t,u), \ \ (x,t) \in \Omega \times (0,T) \\ u\big|_{t=0} = u_0(x), \quad u_t\big|_{t=0} = u_1(x), \quad x \in \Omega \\ u\big|_{x\in\partial\Omega} = \Delta u\big|_{x\in\partial\Omega} = 0, \quad t \geq 0, \end{cases} \qquad (P_\varepsilon)$$

where ε is a small positive parameter.

We investigate the behaviour of the solutions to the problem (P_ε) relative to the corresponding solutions to the unperturbed problem (P_0):

$$\begin{cases} u_t(x,t) + \Delta^2 u(x,t) = f(x,t,u), \ \ (x,t) \in \Omega \times (0,T) \\ u\big|_{t=0} = u_0(x), \quad x \in \Omega \\ u\big|_{x\in\partial\Omega} = \Delta u\big|_{x\in\partial\Omega} = 0, \quad t \geq 0, \end{cases} \qquad (P_0)$$

as $\varepsilon \to 0$.

Torsional creep problems involving Grushin-type operators
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Abstract. The asymptotic behaviour of solutions for a family of torsional creep problems involving the Grushin p-Laplacian is investigated. In particular, our results complement some earlier works on the topic by L. E. Payne & G. A. Philippin [3], B. Kawohl [2] and T. Bhattacharya, E. DiBenedetto and J. Manfredi [1]. This is based on a joint work with Mihai Mihailescu. This presentation is partially supported by CNCS-UEFISCDI Grant No. PN-III-P1-1.1-TE-2019-0456.

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Study of a 3D system modeling tumor immunotherapy

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Abstract. A 3D system modeling the interaction between healthy host cells, effector immune cells and tumour cells, and depending on 8 parameters is considered. The system was obtained by adding a treatment term to the effector cells in a 3D system proposed in [1], as in a previously studied 2D system which did not considered healthy host cells [2].

Under stationary immunotherapy we found that the system may have at most 8 equilibria. Conditions on the parameters that ensure the existence of locally stable stationary states for the system where found. A transcritical bifurcation is emphasized, due to which a new possibility of local stability is obtained.

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On some interesting techniques used for solving integrals

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Abstract. In this paper we show how we can use some famous integral formulas, such as Gaussian integral, Dini integral, Fresnel integral to calculate other interesting integrals, using certain tricks (including derivation with respect to a parameter under the integral sign, development in series of powers or the Laplace transform).

Fredholm property of regular hypoelliptic operators on the scales of multianisotropic spaces

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Abstract. The class of regular hypoelliptic operators is a special subclass of hypoelliptic operators. They are natural generalization of elliptic, parabolic, $2b$–parabolic and quasielliptic operators and have many applications in various anisotropic models. The analysis of regular hypoelliptic operators has certain difficulties as corresponding characteristic polynomials are not homogeneous as in elliptic case. Fredholm properties are studied for special classes of hypoelliptic operators in various functional spaces, but most of the results are related to elliptic and quasielliptic operators (see for example [1], [2], [3], [4], [5]).

In this work we establish necessary and sufficient conditions for a priori estimates for differential operators, acting in multianisotropic Sobolev spaces in $\mathbb{R}^n$. Fredholm criteria and index invariance are

obtained for a wide class of regular hypoelliptic operators on the special scales of multianisotropic weighted spaces.

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Defining the speed independence of the Boolean asynchronous systems

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Abstract. A discrete time Boolean asynchronous system consists in a function $\Phi : \{0,1\}^n \to \{0,1\}^n$ which iterates its coordinates $\Phi_1, ..., \Phi_n$ independently on each other. The durations of computation of $\Phi_1, ..., \Phi_n$ are supposed to be unknown. The design of such systems has as main challenge characterizing their dynamics in conditions of uncertainty. For this, a very cited classical paper is [1], where the fundamental concept of speed independence is introduced. The point is, like in most of these cases, that the authors give (the engineers) intuition, not rigorous definitions and proofs. Our aim is to try a mathematical reinforcement of the Muller's theory of the asynchronous circuits, which should be a modest homage, over time, to its authors.

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Large time behavior of solutions to a system of coupled nonlinear oscillators via a generalized form of the Schauder–Tychonoff fixed point theorem

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Abstract. We consider a mechanical system consisting of two coupled damped nonlinear oscillators, as shown in the figure below. The two blocks have the same mass, m, and we suppose that the stiffnesses of the springs are represented by the functions $k_i : \mathbb{R}_+ \to \mathbb{R}_+$, $i \in \overline{1,2}$ (where $\mathbb{R}_+ := [0, +\infty)$) and the functions $\widehat{f_i} : \mathbb{R}_+ \to \mathbb{R}_+$, $i \in \overline{1,2}$ denote the friction coefficients of the horizontal surface. We assume that, when the two blocks are in their equilibrium positions, the springs are also in their equilibrium positions. Let the displacements of the blocks from their equilibrium positions be x, y. We suppose that the system

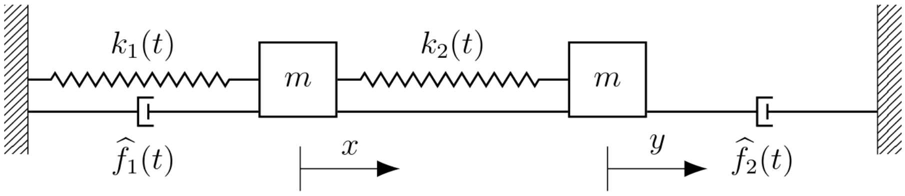

Figure 1. Two 1-D coupled damped nonlinear oscillators

moves under the action of some external forces $\widehat{g}_i : \mathbb{R}_+ \times \mathbb{R} \times \mathbb{R} \to \mathbb{R}$, $i \in \overline{1,2}$, depending on the time and the displacements. Therefore we can associate with the above physical application the following system of ODEs describing the motion of the oscillators

$$\begin{cases} \ddot{x} + 2f_1(t)\,\dot{x} + \beta(t)\,x - \gamma(t)\,y + g_1(t,x,y) = 0, \\ \ddot{y} + 2f_2(t)\,\dot{y} + \delta(t)\,y - \gamma(t)\,x + g_2(t,x,y) = 0, \end{cases} \tag{7}$$

where $\beta(t) := \frac{1}{m}(k_1(t) + k_2(t))$, $\delta(t) := \frac{1}{m}k_2(t)$, $f_1(t) := \frac{1}{m}\widehat{f}_1(t)$, $f_2(t) := \frac{1}{m}\widehat{f}_2(t)$, $\gamma(t) := \frac{1}{m}k_2(t)$, $g_1(t,x,y) := -\frac{1}{m}\widehat{g}_1(t,x,y)$, $g_2(t,x,y) := -\frac{1}{m}\widehat{g}_2(t,x,y)$.
In this talk we will present some results on the stability of the equilibrium of system (7) by using a generalized form of the Schauder–Tychonoff fixed point theorem, on the metrizable locally convex space of the continuous functions defined on a half-line $[t_0, +\infty)$, endowed with a countable family of seminorms as chosen as to determine the uniform convergence on the compact subsets of this interval. We also prove that for any solution (x,y) to system (7) we have $\lim_{t\to+\infty} x(t) = \lim_{t\to+\infty} \dot{x}(t) = \lim_{t\to+\infty} y(t) = \lim_{t\to+\infty} \dot{y}(t) = 0$, for small initial data, in the case when the nonlinearities are not necessarily locally Lipschitz functions (hence uniqueness is not guaranteed). Our theoretical results are illustrated with numerical simulations.

Key words and phrases: coupled oscillators, uniform stability, asymptotic stability, fixed point theorem.
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Numerical Analysis

Meshless methods for solving the singular boundary integral equation of the compressible fluid flow around obstacles

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Abstract. The paper presents some numerical solutions of the singular boundary integral equations of the 2D compressible fluid flow around obstacles. From the SBIEs which can be used to solve the mentioned problem we consider in this paper the SBIE with sources distribution. The numerical solutions are obtained using meshless methods based on different types of radial basis functions. The procedures are implemented into corresponding Mathcad computer codes in order to obtain the numerical solutions

and to make analytical checkings of the proposed methods.A comparison study between the numerical solutions is also presented.

Fitted mesh exact difference method for solution of singularly perturbed time delay parabolic PDEs

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Abstract. Fitted mesh exact finite difference method is developed for solving singularly perturbed parabolic time delay PDE. Solution of the considered PDE exhibits a boundary layer. This makes it stiff for computing the approximate solution using the standard numerical methods on uniform mesh. So, developing numerical scheme which treats the boundary layer behaviour becomes very interesting. The considered PDE is treated using Crank Nicolson method in temporal discretization and fitted mesh exact finite difference method in spatial discretization. The developed scheme satisfies the discrete maximum principle, stability bound and uniform convergence with the boundary layer resolving property (half of the mesh points are in the boundary layer region). To validate the scheme, numerical test examples are considered for different values of perturbation parameter ε and mesh numbers. The scheme gives more accurate result than some results given in the literature.

AMS Subject Classification (2010): 65M06, 65M12, 65M15.
Key words: Fitted mesh exact difference method, Singularly perturbed problem, time delay parabolic PDEs, Uniform convergence.

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