Plenary Talks

International Conference on Nonlinear Differential and Difference Equations: Recent Developments and Applications (ICNDDE 2014), Antalya, Turkey, May 27-30, 2014.

Extension of chaos and applications

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We propose a method for extension of chaos from a prior one to systems with large dimensions. To provide rigorous study of the subject, we introduce new definitions such as chaotic sets of functions, the generator and replicator of chaos, and precise description of ingredients for Devaney and Li-Yorke chaos in continuous dynamics. Input-output mechanisms for the extension are constructed. It is demonstrated that the extension is not the synchronization of chaos. In discussion form we consider inheritance of intermittency, replication of Shil'nikov orbits and quasiperiodical motions as a possible skeleton of a chaotic attractor.

It was observed in experiments by Freeman that a rabbit olfactory bulb EEG is with limit cycle if an odorant is familiar, and it transforms to near-limit cycle chaos otherwise. Watanabe observes that chaos increases the memory capacity. Breakspear and Terry reported the detection of generalized synchronization between different brain regions by means of electroencephalogram signals. Inspired by the phenomena, we have developed chaotic neural network chains. New terminology such as replication of chaos, entrainment by chaos, attraction of chaos by dissipative systems, attraction of chaotic cycles and bifurcation of limit cycles are used for the description of our research.

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On the role of delay differential equations in the joint theory of continuous, discrete and hybrid dynamical systems

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In this paper we give an overview of applications of delay differential equations with piecewise constant arguments (EPCAs). One of the most important applications of EPCAs is the approximation theory. In this case the delay differential equation is first replaced by an EPCA, and then by a discrete difference equation, and the main objective is to relate the qualitative dynamics of these three equations. In some cases the approximations are uniform on the half line and the exponential decay rate of the error may be shown. An open problem is formulated for the qualitative behavior of a class of differential equations with continuous and piecewise constant arguments.The importance of a kind of hybrid system, namely the case when the continuous state equation is controlled by discrete control, is also emphasized.

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Dynamics and implications of a model of Hepatitis B virus infection with time delay

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Chronic HBV affects 350 million people and can lead to death through cirrhosis-induced liver failure or hepatocellular carcinoma. We analyze the dynamics of a model considering logistic hepatocyte growth and a standard incidence function governing viral infection. This model also considers an explicit time delay in virus production. With this model formulation all model parameters can be estimated from biological data; we also simulate a course of lamivudine therapy and find that the model gives good agreement with clinical data. Previous models considering constant hepatocyte growth have permitted only two dynamical possibilities: convergence to a virus free or a chronic steady state. Our model admits a third possibility of sustained oscillations. We show that when the basic reproductive number is greater than 1 there exists a biologically meaningful chronic steady state, and the stability of this steady state is dependent upon both the rate of hepatocyte regeneration and the virulence of the disease. When the chronic steady state is unstable, simulations show the existence of an attracting periodic orbit. Minimum hepatocyte populations are very small in the periodic orbit, and such a state likely represents acute liver failure. Therefore, the often sudden onset of liver failure in chronic HBV patients can be explained as a switch in stability caused by the gradual evolution of parameters representing the disease state.

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Oscillatory criteria for delay and difference equations with several deviating arguments

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Consider the first-order delay differential equation

$$x'(t) + \sum_{i=1}^{m} p_i(t)x(\tau_i(t)) = 0,\ t \geq 0,$$

where, for every $i \in \{1, ..., m\}$, p_i is continuous real-valued function in the interval $[0, \infty)$, and τ_i is a continuous real-valued function on $[0, \infty)$ such that

$$\tau_i(t) \leq t,\ t \geq 0,\ and\ \lim_{t\to\infty} \tau_i(t) = \infty$$

and the discrete analogue difference equation

$$\Delta x(n) + \sum_{i=1}^{m} p_i(n)x(\tau_i(n)) = 0,\ n \in N_0,$$

where N э $m \geq 2$, p_i, $1 \leq i \leq m$, are real sequences and $\{\tau_i(n)\}_{n\in N_0}$, $1 \leq i \leq m$, are sequences of integers such that

$$\tau_i(n) \leq n - 1,\ n \in N_0,\ and\ \lim_{n\to\infty} \tau_i(n) = \infty,\ 1 \leq i \leq m$$

Several oscillation conditions for the above equations are presented.

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Invited Talks

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Asymptotic behavior of solutions of Emden-Fowler dynamic equations

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In this talk, we investigate the asymptotic behavior of solutions of Emden-Fowler dynamic equations on a time scale (nonempty closed subset of real numbers), see [2, 3, 4]. More precisely, all solutions of Emden-Fowler dynamic equations can be divided into several disjoint subsets of means of necessary and sufficient integral conditions. We are interested in the nonexistence of solutions of Emden-Fowler dynamic equations in these subsets as well. We refer the readers to [7, 9, 10] and [1, 8] for the Emden Fowler differential and difference equations, respectively.

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On exponentially separated systems of ordinary differential equations

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We consider exponentially separated linear homogeneous systems of ordinary differential equations with bounded and continuous coefficients in critical case, with zero Lyapunov exponents. The generalized exponential separation with respect to a monotonically increasing function is defined. It has been proven that generalized Lyapunov exponents of these systems are stable with respect to a class of small perturbations.

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Quality of Liapunov discrete-time asymptotical stability parameter and the autonomous discrete time equations

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The first author together with S.K. Godunov suggested the circular dichotomy parameter (1988). With respect to the Liapunov discrete-time asymptotic stablity problem this parameter allows to estimate the region of attraction for the stable solution of the discrete-time autonomous equations (2002). Using the Cauchy Solver software which is prepared by the second author together with Diliaver Eminov one can display the approximation to the stable solution.

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Stability switches in delay difference equations

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This contribution deals with the dependance of the asymptotic stability property of some delay difference equations on changing the delay. This phenomenon is well described for delay differential equations, but related results for their discrete analogues are missing.

The starting point for our investigations is stability analysis of the scalar delay difference equation

$$y(n+1) = \alpha y(n) + \beta y(n-k) \tag{1}$$

with complex coefficients α, β and a positive integer delay k. If α, β are real numbers, then stability properties of (1) are formally simple. A typical stability behaviour of (1) can be described for $\alpha > 0$ and $\beta < 0$, when only three possibilities can occur: (1) is asymptotically stable for all positive integers k, or (1) is not asymptotically stable for any positive integer k, or there exists a unique value of the delay k^*, when (1) loses its asymptotic stability property as k increases monotonically from 1.

If α, β are complex numbers, then the stability behaviour of (1) is much richer. In particular, for a class of complex α, β, (1) switches with respect to increasing k finite times from stability to instability and vice versa. We are going to present a detailed description of such a behaviour and apply the obtained results to some discretized delay population models of Lotka-Volterra type.

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Boundary-value problems with initial jumps for singularly perturbed integro-differential equations

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Equations containing small parameters in the highest derivatives are now called singularly perturbed. This paper considers the asymptotic behavior of the solution of a two-point boundary value problems for a singularly perturbed integro-differential equations of Fredholm type, when the derivatives of the solution at the initial point becomes infinitely large for a sufficiently small value of the parameter. A characteristic feature of such problems is that the solution of a singularly perturbed problem tends to the solution of the degenerate equation with modified conditions when the small parameter tends to zero. In this case we say that there is a phenomenon of the initial jump. First problem of this type, which is called the problem with the initial jump for a nonlinear ordinary differential equation of the second order was studied by M.I. Vishik, L.A. Lyusternik [1] in the case of power growth and by K.A Kasymov [2] in the case of exponential growth. The most common cases of the Cauchy problem with initial jumps for singularly perturbed nonlinear systems of ordinary and integro-differential equations, and partial differential equations of hyperbolic type was studied by K.A Kasymov [2-4].

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Positive solutions of differential equations with deviating arguments

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Delayed equations $y'(t) = f(t, y_t)$, where $f\colon \Omega \mapsto \mathbb{R}^n$, $\Omega \subset \mathbb{R} \times C_1$, $y_t \in C_1$, $C_1 = C([-\tau, 0], R^n)$, $y_t(\theta) = y(t+\theta)$, $\theta \in [-\tau, 0]$, and advanced equations $y'(t) = f(t, y^t)$, where $f\colon \Omega \mapsto \mathbb{R}^n$, $\Omega \subset \mathbb{R} \times C_2$, $y^t \in C_2$, $C_2 = C([0, \tau], R^n)$, $y^t(\theta) = y(t+\theta)$, $\theta \in [0, \tau]$, are considered. Necessary and sufficient conditions for existence of positive solutions (for $t \to \infty$) are discussed.

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Oscillation for higher order differential equations with a middle term

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We study the higher order nonlinear differential equation with a middle term

$$x^{(n)}(t) + q(t)x^{(n-2)}(t) + r(t)f(x(t)) = 0\,, \quad n \geq 3 \tag{1}$$

as a perturbation of the linear differential equation

$$y^{(n)}(t) + q(t)y^{(n-2)}(t) = 0\,. \tag{2}$$

The important role in our approach is played by the relationship between solutions of (2) and those of the second order linear oscillatory equation

$$h''(t) + q(t)h(t) = 0\,. \tag{3}$$

We prove the existence of bounded oscillatory solutions and the nonexistence of vanishing at infinity solutions of (1).

As an application, we obtain the asymptotic equivalence of the linear equations (2) and

$$x^{(n)}(t) + q(t)x^{(n-2)}(t) + r(t)x(t) = 0\,. \tag{4}$$

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Well-posednes and parameter identification problems in a class of neutral differential equations with state-dependent delays

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In this talk we consider a class of neutral differential equations with state-dependent delays. First we study well-posedness questions, and then we formulate a parameter identification algorithm and establish its theoretical convergence. The discretization of the differential equation is based on an Euler-type approximation method using equations with piecewise constant arguments. Numerical examples are included.

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Global periodicity and the existence of an equlibrium in linear difference equations

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It is proved that any first order globally periodic linear inhomogeneous autonomous difference equation defined by a linear operator with closed range in a Banach space has an equilibrium. This result is extended for higher order linear inhomogeneous system in a real or complex Euclidean space. The work was highly motivated by early works P. A. Smith (1934, 1941) and the papers of J. M. Kister (1961) and A. L. Bas (2011).

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On solution of the finite Toda and Langmuir lattices by the inverse spectral method

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In this talk, we construct solutions of the finite Toda and Langmuir lattices by use of the inverse spectral method. The corresponding Lax operator is a finite Jacobi matrix (tri-diagonal symmetric matrix). The concept of spectral data for finite Jacobi matrices is introduced and a complete solution of the inverse spectral problem is presented.

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On Diamond-Alpha dynamic inequalities and applications

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Beginning with a background of diamond-alpha derivatives and integrals, we give a survey of diamond-alpha type dynamic inequalities, and some applications.

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Fractional calculus: fundamentals and applications

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Fractional Calculus (FC) started in 1695 when L'Hôpital wrote a letter to Leibniz asking for the meaning of $D^n y$ for $n = 1/2$. Starting with the ideas of Leibniz many important mathematicians developed the theoretical concepts. By the beginning of the twentieth century Olivier Heaviside applied FC in the electrical engineering, but, the visionary and important contributions were forgotten. Only during the eighties FC emerged associated with phenomena such as fractal and chaos and, consequently, in nonlinear dynamical. This lecture introduces the FC fundamental mathematical concepts, and reviews the main computational approaches for implementing fractional operators. In the last years Fractional Calculus (FC) become 'new' tool for the analysis of dynamical systems. Based on the FC mathematical concepts, this lecture presents several applications in the areas of systems modeling and control.

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Large time behavior of a linear delay differential equation with asymptotically small coefficient

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In this talk, we will consider the linear delay differential equation

$$x'(t) = p(t)x(t-r), \qquad t \geq t_0,$$

where $r > 0$ and $p : [t_0, \infty) \to \mathbb{R}$ is a continuous function which is small as $t \to \infty$. We will show that the large time behavior of the solutions can be described in terms of a special solution of the associated formal adjoint equation and the initial data. In the special case of the Dickman-de Bruijn equation

$$x'(t) = -\frac{x(t-1)}{t}, \qquad t \geq 1,$$

our result yields an explicit asymptotic representation of the solutions as $t \to \infty$.

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Sturm comparison theorems for linear and half-linear equations with damping terms

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In this talk, first we will give a survey of the most basic results on Picone identity and Picone-type inequalities for linear and half-linear equations. Next we will give some Sturm comparison theorems via the Picone-type inequality. Finally, we will present some new results on a pair of elliptic type linear and half-linear equations with damping terms.

Contributed Talks

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Dual Identities in Fractional Difference Calculus

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Discrete fractional calculus started to attract the attention of many researchers in the last five years or so. Two approaches are followed to obtain discrete fractional orders. The first approach is through iterating the summation to obtain the discrete Cauchy formula and then define delta and nabla type Riemann fractional differences. The second approach is achieved by iterating either the delta or nabla operators and obtaining fractional sums and differences with binomial coefficients. Delta and nabla Caputo and Riemann type fractional differences are defined and confirmed through the investigation of two types of dual identities. The first type relates nabla and delta type fractional sums and differences. The second type represented by the Q-operator relates left and right fractional sums and differences. These dual identities insist that in the definition of right fractional differences we have to use both the nabla and delta operators. Some integration by parts formulas are obtained for the Riemann and Caputo type differences and the solution of some Riemann and Caputo initial fractional difference value problems are presented.

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Direct and inverse scattering problems for the one dimensional Schrödinger equation with the energy dependent potential and impulse

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This work studies the direct and inverse scattering problems on the real axis for the one dimensional Scrödinger equation with the potential linearly dependent on the spectral parameter and with the discontinuity conditions at some point. The new integral representations for the Jost solutions of the equation

$$-y'' + q(x)y + 2\lambda p(x)y = \lambda^2 y,\ x \in (-\infty, +\infty) \tag{1}$$

with the discontinuity conditions

$$y(a^-) = \alpha y(a^+),\ y'(a^-) = \alpha^{-1} y'(a^+) \tag{2}$$

which is also called as impulse, are constructed. Here λ is the spectral parameter, $y = y(x, \lambda)$ is an unknown function and $q(x), p(x)$ are real valued function defined on the real line with following conditions:

(1) the function $q(x)$ is locally summable;

(2) the function $p(x)$ is absolutely continuous on each finite segment;

(3) $(1 + |x|)\, q(x), (1 + |x|)\, p'(x), p(x) \in L_1(-\infty, +\infty)$.

Using the new integral representations it is investigated the properties of the scattering data, obtained the main integral equations of the inverse scattering problem, also given necessary and sufficient conditions characterizing the scattering data in the case when there is no discrete spectrum.

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On the solution of a boundary value problem related to the heat conduction

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In this work, we consider a heat conduction problem which has derivative with respect to the time in boundary condition. Applying the seperation of variables method, we get a second order differential equation with discontinuous coefficient and a spectral parameter dependent boundary condition. For this spectral problem the operator theoretic formulation is investigated in the Hilbert space $H_\rho = L^2_\rho(0,\infty) \times \mathbb{C}$. The resolvent operator is constructed and the expansion formula with respect to the eigenfunctions is obtained. Finally, using the expansion formula, we obtain a formula for the solution of problem.

Key Words: Heat Conduction, Resolvent Operator, Expansion Formula.

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International Conference on Nonlinear Differential and Difference Equations: Recent Developments and Applications (ICNDDE 2014), Antalya, Turkey, May 27-30, 2014.

Maximum principle for the fractional diffusion equations with the Riemann-Liouville fractional derivative and their applications

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In this paper, the initial-boundary-value problems for the one dimensional linear and non-linear fractional diffusion equations with the Riemann-Liouville time-fractional derivative are analyzed. First, a weak and a strong maximum principles for solutions of the linear problems are derived. These principles are employed to show uniqueness of solutions of the initial-boundary-value problems for the non-linear fractional diffusion equations under some standard assumptions posed on the non-linear part of the equations. In the linear case and under some additional conditions, these solutions can be represented in form of the Fourier series with respect to the eigenfunctions of the corresponding Sturm-Liouville eigenvalue problems.

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About convergence for finite-difference equations of incompressible fluid in stream function, vorticity variables with boundary conditions by Woods formulae

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In square domain $D = \{0 \le x, y \le 1\}$ let us study the following system of Navier-Stokes steady-state equations in variables stream function, velocity curl for incompressible fluid [1]

$$\left(\Omega\frac{\partial\Psi}{\partial y}\right)_x - \left(\Omega\frac{\partial\Psi}{\partial x}\right)_y = \nu\Delta\Omega + f(x,y), \tag{1}$$

$$\Delta\Psi = \Omega, \quad (x,y) \in D, \tag{2}$$

with following boundary conditions

$$\Psi = \frac{\partial\Psi}{\partial n} \mid_{\partial D} = 0, \tag{3}$$

where $\nu > 0$ is viscosity coefficient, $\vec{n}$ is outer normal to domain boundary, Δ is two-dimensional Laplace operator, $f(x,y)$ is some given function, Ψ is stream function, Ω is vortisity curl.

For approximation of equations (1), (2) in finite-difference domain $D_h = \{(kh_1, mh_2), k, m \in \overline{1, N-1}\}$, where h_1 and h_2 are grid steps in x and y directions, respectively, we examine the following scheme on symmetrical pattern

$$L_h(\Omega)\Psi = \nu\Delta_h\Omega + f, \tag{4}$$

$$\Delta_h\Psi = \Omega, \tag{5}$$

where L_h is difference operator, which complies with respective approximation of convectional summands of equation (1).

In our investigation the boundary conditions for velocity curl are taken in the form of Woods formulas [1,2]. It is shown that the solution of the difference problem (4),(5) with boundary conditions converges to the solution of the differential problem (1)-(3). For the error of the estimate of convergence of solutions $\|\Delta_h\Phi\| \le c_0h^2$, where c_0 is a uniformly bounded constant.

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Pattern formation in integro-differential equations with or without non-local diffusion

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We consider a spatial generalization of basic logistic equation modeling one species with non-local consumption of resources. Recently pattern formation mechanism has been detected in this equation with a laplacian modeling local diffusion. Here our aim is to show that it is possible to obtain pattern formation without the laplacian term. Using linear stability analysis, we find the conditions required for formation of patterns in the equation with or without non-local diffusion. Comparison of models with local and non-local diffusion terms will be presented via numerical simulations.

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Infinitely many solutions for a class of perturbed sublinear Schrödinger equations in $\mathbb{R}^N$ with an indefinite functional

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In this talk, we consider the following class of modified sublinear schrödinger equations

$$-\Delta u + V(x)u - \Delta(u^2)u = a(x)\,|u|^{q-1}\,u + f(x), \quad x \in \mathbb{R}^N, \tag{1}$$

where $N \geq 3, \quad 0 < q < 1, \quad f \geq 0, \quad f \neq 0$ and $f \in L^2\left(\mathbb{R}^N\right) \cap L^{\frac{2N}{N+2}}\left(\mathbb{R}^N\right)$.
We look for the existence of infinitely many solutions for problem (1), where the potential V and the weight $a(x)$ are a sign-changing functions in $\mathbb{R}^N$. We give a new critical point theorem to prove the desired result.

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The maximum principle for structured populations with diffusion

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We prove a weak maximum principle for structured populations models with dynamic boundary conditions. We establish existence and positivity of solutions of these models and investigate the asymptotic behaviour of solutions. In particular, we analyse so called size profile.

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The fractional Adams-Bashforth-Moulton method for linear and nonlinear fractional ordinary differential equation

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In this research newly submitted to the literature, we have taken into consideration the Fractional Adams-Bashforth-Moulton method to obtain numerical solutions of linear and nonlinear fractional ordinary differential equations. After we executed 2D surfaces of numerical solutions, analytical solutions and the numbers of errors by taking into account suitable interval, we carried out a table involving numerical results and errors. Under the terms of obtained numerical results, it has been shown that this method is quite suitable for solving such a differential equations.

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Investigation of interval stability of discrete systems

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Consider the system

$$x\left(k+1\right)=\left(A+\Delta A\right)x\left(k\right),\quad k=1,2,\ldots \tag{1}$$

where coefficients of an $n\times n$ matrix $\Delta A=\left(\Delta a_{ij}\right)_{i,j=1}^{n}$ can take values from some preassigned intervals $[-\alpha_{ij},\alpha_{ij}]$, $i,j=1,2,\ldots,n$, and $\alpha_{ij}\geq 0$ are given numbers, i.e.

$$\left|\Delta a_{ij}\right|\leq\alpha_{ij},\quad i,j=1,2,\ldots,n. \tag{2}$$

Systems (1) with coefficients satisfying (2) are called the interval systems.

If the system (1) is asymptotic stable for arbitrary coefficients of the matrix $\Delta A=\left(\Delta a_{ij}\right)_{i,j=1}^{n}$, satisfying the conditions (2), then the system

$$x\left(k+1\right)=Ax\left(k\right),\quad k=1,2,\ldots \tag{3}$$

is called interval asymptotic stable. In the talk, we give criteria of interval asymptotic stability of the system (3). Systems with delay

$$x\left(k+1\right)=Ax\left(k\right)+Bx\left(k-m\right),\quad k=1,2,\ldots$$

where B is an $n\times n$ matrix and m is a positive integer will be investigated on interval asymptotic stability as well.

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Derivation of systems of stochastic differential equations (SDEs) for macroevolution

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Systems of stochastic differential equations (SDEs) are derived that describe the evolutionary dynamics of genera and species. Two different hypotheses are made in the model construction, specifically, the rate of change of the number of genera is either proportional to the number of genera in the family or is proportional to the number of species in the family. Asymptotic mean numbers of species per genera are derived for both hypotheses. Computational results for the derived systems of SDEs agree well with the observed results for several families.

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Lyapunov-type inequalities for nonlinear systems

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In this talk, we establish new Lyapunov-type inequalities for nonlinear systems which generalize and improve some known results in the literature.

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Periodic solutions of a spring-mass system with piecewise constant forces

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In this study, we consider a damped spring-mass system with piecewise constant argument of generalized type. We investigate the existence of periodic solutions of the system subjected to external linear and also nonlinear piecewise constant forces. Using the theoretical results obtained by Akhmet [1,2], we analyze the periodic behaviour of the model under discussion. We provide conditions based on the parameters of the system.

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Solving fractional order non-linear systems by using approximate techniques: some comparisons

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Fractional order differential equations and a system of such equations have been proved to be valuable tools for the modelling of many phenomena such as fluid dynamics, physics, electrochemistry, mathematical biology, viscoelasticity and etc. Finding solutions to such equations or system of equations are in general not an easy task. We propose a method, which is called differential transform method, of solving a non-linear system of fractional order equations and compare the results with some of the other techniques. Several examples with numerical simulation are provided to illustrate the simplicity and effectiveness of the method.

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Chaotification of impulsive systems by perturbations

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In this study, a new method of chaos generation proposed in papers [M.U. Akhmet, Devaney's Chaos of a Relay System, Commun. Nonlinear Sci. Numer. Simulat. 14 (2009) 1486-1493; M.U. Akhmet, M.O. Fen, Replication of Chaos, Commun. Nonlinear Sci. Numer. Simulat. 18 (2013) 2626-2666] is applied for non-autonomous impulsive systems. Taking advantage of perturbations, we prove the presence of chaotic dynamics. An example, which supports the theoretical results, is presented.

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On discontinuous Dirac systems with eigenvalue dependent boundary conditions

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In this paper, we consider Dirac system with eigenvalue dependent boundary conditions. Then we obtain the existence and uniqueness results of solutions by modifying some known techniques for the investigated problem. Inverse problems for discontinuous Sturm-Liouville operator were given in [1] and [4]. [2] and [3] are examples of works about direct and discontinuous Dirac systems.

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Recovery of the impulsive diffusion operator with discontinuous coefficient

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In this work impulsive diffusion operator with discontinuous coefficient is considered. Integral representation is derived and some important properties of eigenvalues are studied. Moreover, it is proven that the coefficients of the given problem are uniquely determined by the Weyl function.

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Non-autonomous bifurcation in impulsive systems

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This is the first paper which considers non-autonomous bifurcations in impulsive differential equations. Impulsive generalizations of the non-autonomous pitchfork and transcritical bifurcation are discussed. We consider scalar differential equation with fixed moments of impulses. It is illustrated by means of certain systems how the idea of pullback attracting sets remains a fruitful concept in the impulsive systems. Basics of the theory are provided.

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Lyapunov type inequalities and inhomogenous boundary value problems for linear Hamiltonian systems under impulse effect

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In this talk two existence and uniqueness criteria for the solutions of inhomogenous BVPs are proved by using Lyapunov type inequalities. Moreover the unique solution of inhomogenous BVP has been expressed in terms of Green's function (pair) and properties of Green's function (pair) have been stated. Our criteria are the first results which give the relation between existence and uniqueness theory of boundary value problems and Lyapunov type inequalities. This relation has not been noticed even for the ordinary differential equations case.

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Approximations of solutions to nonlinear differential equations with a deviated argument

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In this talk, we are concerned with the approximations of solutions to nonlinear differential equations with a deviated argument in a separable Hilbert space H. We consider an integral equation associated with given problem and then consider a sequence of approximate integral equations. We prove the existence, uniqueness and convergence to each of the approximate integral equation by using the analytic semigroup theory and the fixed point method, also prove the limiting function satisfies the associated integral equation. Finally, we consider the Faedo-Galerkin approximations of solutions and prove some convergence results.

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Asymptotic behavior of second order neutral difference equations with delays

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By using discrete analogue of Bihari's inequality we will establish asymptotic behavior of solutions for the second order neutral delay difference equation

$$\Delta^2 \left(x\left(n\right) + px\left(n-\tau\right) + qx\left(n-\sigma\right)\right) + f\left(n, x\left(n\right)\right) = 0 \tag{1}$$

Moreover, we study an other second order and a third order neutral delay difference equations that similar to our main equation 1. Finally, some examples are given to illustrate our results.

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Existence Results for a Singular Boundary value problem on unbounded domains in Banach spaces

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In this talk, we use the Krasnosels'kii fixed point theorem in cones for strict set-contractions to investigate the existence of single and twin positive solutions for a class of a two-point boundary value problem of second-order nonlinear differential equations posed on an infinite interval. The nonlinearity, which may have a time-singularity, takes values in a general Banach space and has at most polynomial growth with respect to the unknown. Notice that the main difficulty in dealing with such BVPs is the lack of compactness of the fixed point operator. Motivated by the results obtained in the scalar case by Djabali et Mebarki, the main feature of this work is to discuss some existence results when the nonlinear term f takes values in an abstract Banach space.

Key Words: boundary value problem, Green's function, ODE, unbounded interval, compactness criterion, fixed point theorem, dual cone, MNC, strict setcontraction, Banach space.

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Growth of solutions of certain class of nonhomogeneous linear differential equations

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In this paper we will investigate the growth of solutions of certain class of nonhomogeneous linear differential equations with entire coefficients having the same order and type.

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Analytical solutions of time space fractional, advection-dispersion and Whitham-Broer-Kaup equations

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In this article, we study time-space fractional advection-dispersion (FADE) equation and time-space fractional Whitham-Broer-Kaup (FWBK) equation that have a significant role in hydrology. We introduce suitable transformations to convert fractional order derivatives to integer order derivatives and as a result these equations transform into partial differential equations (PDEs). Then the Lie symmetries and corresponding optimal systems of the resulting PDEs are derived. The symmetry reductions and exact independent solutions based on optimal system are investigated which constitute the exact solutions of original fractional differential equations.

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Ultimate boundedness of solutions of nonlinear vector differential equations of third order

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We present in this paper, by using Lyapunov's second method the ultimate boundedness of solutions of nonlinear vector differential equations of the third order. We provide in simple form sufficient conditions which ensure ultimate boundedness of solutions. Results obtained, generalize, improve and include those results obtained by previous authors.

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A novel approach for developing PDE models of the spread of invasive species

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We develop generalized models of biological invasions (PDE models) and use a modified genetic algorithm to orchestrate a competition among the models in order to select the "optimal" model that fits the ground truth data. We use data of the spread of Zebra mussels in Lake Champlain in Vermont, USA for this modeling approach.

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Sturmian theory for second order differential equations with mixed nonlinearities

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In the paper, Sturmian comparison theory is developed for the pair of second order differential equations; first of which is the nonlinear differential equations

$$(m(t)y')' + s(t)y' + \sum_{i=1}^{n} q_i(t)|y|^{\alpha_i - 1}y = 0, \qquad (\mathbf{A})$$

with mixed nonlinearities $\alpha_1 > \ldots > \alpha_m > 1 > \alpha_{m+1} > \ldots > \alpha_n$, and the second is the nonselfadjoint differential equations

$$(k(t)x')' + r(t)x' + p(t)x = 0. \qquad (\mathbf{B})$$

Under the assumption that the solution of Eq. (**B**) has two consecutive zeros, we obtain Sturm-Picone type and Leighton type comparison theorems for Eq. (**A**) by employing the new nonlinear version of Picone's formula that we derive. Wirtinger type inequalities and several oscillation criteria are also attained for Eq. (**A**). Examples are given to illustrate the relevance of the results.

Key Words: Comparison, Leighton, Mixed nonlinear, Nonselfadjoint, Sturm-Picone, Wirtinger.

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Self-Similar asymptotics for linear and nonlinear mathematical models of tumor angiogenesis

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We show that the long time asymptotic solutions of initial value problems for linear and nonlinear mathematical models of tumor angiogenesis are self-similar spreading solutions. The symmetries of the governing equations yield three-parameter families of these solutions given in terms of their mass, center of mass, and variance. Unlike the mass and center of mass, the variance, or "time-shift," of a solution is not a conserved quantity for the nonlinear problem. We derive an optimal linear estimate of the long-time variance.

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Traveling wave solutions of degenerate coupled KdV equation

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In this talk, we give a detailed study of the traveling wave solutions of (*l* = 2) Kaup-Boussinesq type of coupled KdV equations. Depending upon the zeros of a fourth degree polynomial, we have cases where there exist no nontrivial real solutions, cases where asymptotically decaying to a constant solitary wave solutions, and cases where there are periodic solutions. All such possible solutions are given explicitly in the form of Jacobi elliptic functions. Graphs of some exact solutions in solitary wave and periodic shapes are exhibited.

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Constantin's inequality for Nabla and Diamond - Alpha derivatives

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Calculus for Dynamic Equations on Time Scales which offers a unification of discrete and continuous systems is a recently developed theory. Our main aim is to investigate Constantin's Inequality on Time Scales that is an important tool used in determining some properties of various dynamic equations such as global existence,uniquness and stability. In this talk, Constantin's Inequality is investigated in particular for nabla and the diamond-alpha derivatives.

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Conjugacy of a discrete semidynamical systems

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In Banach space $\mathbf{E} \times \mathbf{F}$ the system of noninvertible difference equations

$$\begin{aligned} x(t+1) &= g(x(t)) + \Psi(x(t), r(t)), \\ r(t+1) &= A(x(t))r(t) + \Phi(x(t), r(t)) = R(x(t), r(t)) \end{aligned} \tag{1}$$

is considered. Sufficient conditions under which there is an local Lipschitzian invariant manifold $u\colon \mathbf{E} \to \mathbf{F}$ are obtained. Using this result we find sufficient conditions under which the system of difference equations (1) is conjugated to

$$\begin{aligned} x(t+1) &= g(x(t)) + \Psi(x(t), u(x(t))), \\ r(t+1) &= R(x(t) + v(x(t), r(t)), r(t)). \end{aligned} \tag{2}$$

This result allows one to replace the given system by a much simpler one. Relevant results concerning partial decoupling and simplifying of the system of invertible difference equations are given also.

This work was partially supported by the grant Nr. 345/2012 of the Latvian Council of Science.

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Initial value problem for abstract parabolic equations appearing in atmospheric dispersion of pollutants

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The main objective of the present talk, is to discusse the initial and integral boundary value problem for the following nonlinear degenerate parabolic equation

$$\frac{\partial u}{\partial t}+\sum_{k=1}^{n}a_k(x_k)\frac{\partial^2 u}{\partial x_k^2}+B((t,x,u,\nabla u))u=F(t,x,u,\nabla u), \tag{1}$$

where $a_k(x)$ are complex valued functions, B and F are nonlinear operators in a Banach space E and

$$\nabla u=(\frac{\partial u}{\partial x_1},\frac{\partial u}{\partial x_2},...,\frac{\partial u}{\partial x_n}),x=(x_1,x_2,...,x_n)\in G=\prod_{k=1}^{n}(0,b_k),$$

First, we consider the for the elliptic operator differential equation with small parameters

$$\sum_{k=1}^{n}\varepsilon_k a_k(x_k)\frac{\partial^2 u}{\partial x_k^2}+A(x)u+\lambda u+\sum_{k=1}^{n}\varepsilon_k^{\frac{1}{2}}A_k(x)\frac{\partial u}{\partial x_k}=f(x), \tag{2}$$

where a_k are complex-valued functions, ε_k are small parameters, $A(x)$ and $A_k(x)$ are linear operators, λ is a complex parameter. We prove that, for $f\in L_{\mathbf{p}}(G;E)$, $|\arg\lambda|\leq\varphi$, $0<\varphi\leq\pi$ and sufficiently large $|\lambda|$, problem (**2**) has a unique solution $u\in W_{\mathbf{p}}^{[2]}(G;E(A),E)$ and the following coercive uniform estimate holds

$$\sum_{k=1}^{n}\sum_{i=0}^{2}|\lambda|^{1-\frac{k}{2}}\varepsilon_k^{\frac{i}{2}}\|\frac{\partial^{[i]}u}{\partial x_k^i}\|_{L_p(G;E)}+\|Au\|_{L_p(G;E)}\leq C\|f\|_{L_p(G;E)}.$$

Especially, it is shown that the corresponding differential operator is positive and also is a generator of an analytic semigroup. Then by using this result, we prove the well-posedeness in $L_{\mathbf{p}}(G;E)$ to initial and BVP for the following degenerate abstract parabolic equation with parameters

$$\frac{\partial u}{\partial t}+\sum_{k=1}^{n}\varepsilon_k a_k(x_k)\frac{\partial^2 u}{\partial x_k^2}+A(x)u=f(x,t),\ t\in(0,T),\ x\in G. \tag{3}$$

Finally, via maximal regularity properties of (**3**) and contaction mapping argument we derive the exsistence and uniqueness of solution of the problem (**1**).

In application, we consider the system of reaction-advection-diffusion system that serves as a model used to describe photochemical generation and atmospheric dispersion of ozone and other pollutants.

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Limiting subdifferential and application

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The concept of differentiability plays a crucial role in the study of optimization problems. The origins of nonsmooth analysis back to the early 70s when theorists control and non-linear programming have been tried to establish the necessary conditions of optimality for problems with non-smooth data. Recently, several concepts in differential and regularity of functions and sets have been developed. Among these concepts, our focus is on the limiting subdifferential introduced by Mordukhovich and approached problems introduced by Ioffe. In order to generate optimality conditions in different situations knowing that the case data of an optimization problem with inequality and equality constraints are differentiable, convex and locally Lipschitz, the theory has been made. To our knowledge, which is new the is case where the problem data are lower semi-continuous.

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Study of an inverse problem that models the detection of corrosion in a corner of metalic tube whose lower part is embedded

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In this work, we will study an inverse problem to determine corrosion in an inaccessible location of a corner of metalic tube. Our study area is inside the corner of the metalic tube whose lower part is embedded therefore inaccessible. We will perform measurements on the upper part of the plate, which is not in contact with the ground. For this, we will send an electric field on this part and take measurements. This problem is modeled by a Laplace problem with mixed presence of an unknown term in the boundary conditions. This term is an unknown function which can take several forms. It is this function that we will detect the presence or absence of corrosion inside the tube and we will then follow our steps to the top edge of the field information on the evolution of this corrosion. We will first formulate our problem which is an inverse problem and we will make a theoretical study and we will show that this problem has a unique solution also this solution is stable. After, we will solve this problem by constructing an iterative algorithm which gives problems that will cross a series of impedance functions which determines the rate of corrosion. Finally, we study the convergence and we will then make a numerical application.

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Inverse problem for the quadratic pencil of the Sturm-Liouville equations

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We study the wellposedness of the inverse problem for the quadratic pencil of the Sturm-Liouville equation (diffusion operator). We will consider two different problem for diffusion operator. By using the Mizutani's method, we will prove that if the spectral characteristics of this problems are close to each other, then the difference between their potential functions is suffciently small in a certain sense.

International Conference on Nonlinear Differential and Difference Equations: Recent Developments and Applications (ICNDDE 2014), Antalya, Turkey, May 27-30, 2014.

Abstract Stokes problem with variable coefficients in half space and applications

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In this talk, stationary and instationary degenerate abstract Stokes problem is considered. The elliptic part possess the variable coefficients and abstract operator in principal part. The well-possedenes of these problems are derived in Banach space valued L^p class. We consider the initial and nonlocal boundary value problem for the following Stokes type equation

$$\frac{\partial u}{\partial t}-\sum_{k=1}^{n}a_k\left(x\right)\frac{\partial^2 u}{\partial x^2}+Au+\nabla\varphi=f\left(x,t\right),\ divu=0,\ x\in R_+^n,\ t\in\left(0,T\right), \qquad (1)$$

where $R_+^n=\{x:\ x=(x_1,x_2,...,x_n),\ x_n>0\}$, A is a linear operator in a Banach space E and a_k are complex-valued functions. Here

$$f=\left(f_1\left(x,t\right),f_2\left(x,t\right),...,f_n\left(x,t\right)\right)$$

is a given, a is an initial data; $u=\left(u_1\left(x,t\right),u_2\left(x,t\right),...,u_n\left(x,t\right)\right)$ and $\varphi=\varphi\left(x,t\right)$ are unknown functions. We prove that there is a unique solution $(u,\nabla\varphi)$ of the problem (1) for $f\in\left(L^{p,q}\left(0,T\right)\times G;E\right)^n$, $a\in Y_{p,q}$ and the following coercive estimate holds

$$\left\|\frac{\partial u}{\partial t}\right\|_{L^{p,q}}+\sum_{k=1}^{n}\left\|D_k^{[2]}u\right\|_{L^{p,q}}+\left\|Au\right\|_{L^{p,q}}+\left\|\nabla\varphi\right\|_{L^{p,q}}\leq C\left(\left\|f\right\|_{L^{p,q}}+\left\|a\right\|_{Y_{p,q}}\right),$$

where $Y_{p,q}$ is a corresponding interpolation space between the spaces

$$\left(L^p\left(R^{n-1};E\right)\right)^n,\left(W^{p,2}\left(R^{n-1};E\left(A\right),E\right)\right)^n,$$

and $L^p\left(R^{n-1};E\right)$, and $W^{p,2}\left(R^{n-1};E\left(A\right),E\right)$ are E-valued L^p and Sobolev-Lions type spaces.

Since the Banach space E is arbitrary and A is a possible linear operator, by chousing spaces E and operators A we can obtained numerous class of Stokes type problems. For $a_k\equiv1$, $E=\mathbb{C}$, $A=\varkappa$ and $\varkappa$ is a positive constant, the problem (1) is reduced to classical Stokes problem.

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A fractional order model on bilingualism

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A fractional order nonlinear model of one unilingual component and one bilingual component of a population is developed. Equilibrium points are found and their stability is investigated. Also, numerical solutions are obtained for an example of the system.

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H_∞ Control and Input-to-State stabilization for hybrid systems with time delay

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This paper addresses the problem of designing a robust reliable H_∞ control and a switching law to guarantee input-to-state stabilization (ISS) for a class of uncertain switched control systems with time delay not only when all the actuators are operational, but also when some of them experience failure. The output of faulty actuators are treated as a disturbance signal that is augmented with the system disturbance input. Multiple Lyapunov function with Razumikhin condition, and average dwell time switching signal are used to establish the ISS property. To clarify the theoretical results, a numerical example with simulation is presented.

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Asymptotic properties of delayed matrix functions and Lambert function

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The application of the well-known "step by step" method (when ordinary differential equations with delay are solved) was recently, in the case of linear systems of first order with single constant delay and with constant matrix, formalized using special types of delayed matrices (delayed matrix exponential, delayed matrix sine and delayed matrix cosine). These matrix functions are defined on intervals $(k-1)\tau \leq t < k\tau$, $k = 0, 1, \ldots$ (where $\tau > 0$ is a delay) as matrix polynomials, and are continuous at nets $t = k\tau$. In the talk asymptotic properties of delayed matrix exponential are studied for $k \to \infty$ and it is proved that the sequence of values of delayed matrix exponential at nets is approximately represented by a geometric progression. It is found a constant matrix such that its matrix exponential is the "quotient" factor which depends on the principal branch of Lambert function. Derived formulas can be applied to study of asymptotic properties of solutions of linear differential systems with constant matrices and with a single delay.

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Existence and uniqueness of monotone and bounded solutions for a finite-difference discretization à la Mickens of the generalized Burgers-Huxley equation

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Departing from a generalized Burgers-Huxley partial differential equation, we provide a Mickens-type, nonlinear, finite-difference discretization of this model. The continuous system is a nonlinear regime for which the existence of traveling-wave solutions has been established previously in the literature. We prove that the method proposed also preserves many of the relevant characteristics of these solutions, like the positivity, the boundedness, and the spatial and the temporal monotonicity. The main results provide conditions that guarantee the existence and the uniqueness of monotone and bounded solutions of our scheme. The technique was implemented and tested computationally, and the results confirm both a good agreement with respect to the traveling-wave solutions reported in the literature, and the preservation of the mathematical features of interests.

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On an effective method for the numerical solution of elliptic equations with discontinuous coefficients

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In this paper, the equation of elliptic type with strongly varying coefficients is considered. The equations of this type are obtained in the second step of the splitting method for solving the Navier-Stokes equations for a viscous incompressible fluid, atmospheric boundary layer in the areas of complex shape.

In [1] economic (with respect to number of actions) alternately triangular scheme of second-order accuracy for the numerical solution of elliptic equations is suggested. In [2] a modified alternate-triangular iterative method with Chebyshev parameters of the second order accuracy for the Dirichlet difference problem for an elliptic equation is built. In the V. Lebedev's monograph [3] the application of the method of composition for finding solutions for eigenvalue problems, time-dependent problems, the Dirichlet problem for the biharmonic equation and grid problems is considered. In [4] the difference stationary problem for the Poisson equation with piecewise constant coefficients in subdomains is studied.

In this paper a special method for the numerical solution of elliptic equations with strongly varying coefficients is proposed. The proposed method is based on special substitution of variables which reduces the problem with discontinuous coefficients of the second kind to a problem with discontinuous coefficients of the first kind. An iterative process with two parameters taking into account the ratio of the coefficients of the equation in subdomains is built. A theorem for the rate of convergence of the developed iterative process is proved. Computational algorithm and numerical calculations to illustrate the effectiveness of the proposed method are developed.

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Existence of positive solutions for p-Laplacian impulsive boundary value problems

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In this paper, by using a fixed point theorem in a cone, we investigate the existence of positive solutions for a second-order p-Laplacian impulsive boundary value problem. As an application, an example is given to illustrate our main results.

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Positive solutions for a second-order discrete multi-point eigenvalue problem

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We investigate the system of nonlinear second-order difference equations

$$(S) \qquad \begin{cases} \Delta^2 u_{n-1} + \lambda s_n f(n, u_n, v_n) = 0, \ \ n = 1, \ldots, N-1, \\ \Delta^2 v_{n-1} + \mu t_n g(n, u_n, v_n) = 0, \ \ n = 1, \ldots, N-1, \end{cases}$$

with the multi-point boundary conditions

$$(BC) \qquad u_0 = \sum_{i=1}^{p} a_i u_{\xi_i}, \ \ u_N = \sum_{i=1}^{q} b_i u_{\eta_i}, \ \ v_0 = \sum_{i=1}^{r} c_i v_{\zeta_i}, \ \ v_N = \sum_{i=1}^{l} d_i v_{\rho_i},$$

where $N \in \mathbf{N}$, $N \geq 2$, p, q, r, $l \in \mathbf{N}$, Δ is the forward difference operator with stepsize 1, $\Delta u_n = u_{n+1} - u_n$, $\Delta^2 u_{n-1} = u_{n+1} - 2u_n + u_{n-1}$, $\xi_i \in \mathbf{N}$ for all $i = 1, \ldots, p$, $\eta_i \in \mathbf{N}$ for all $i = 1, \ldots, q$, $\zeta_i \in \mathbf{N}$ for all $i = 1, \ldots, r$, $\rho_i \in \mathbf{N}$ for all $i = 1, \ldots, l$, $1 \leq \xi_1 < \ldots < \xi_p \leq N-1$, $1 \leq \eta_1 < \cdots < \eta_q \leq N-1$, $1 \leq \zeta_1 < \cdots < \zeta_r \leq N-1$ and $1 \leq \rho_1 < \cdots < \rho_l \leq N-1$.

By using the Guo-Krasnosel'skii fixed point theorem, we prove some existence results for the positive solutions of problem $(S) - (BC)$. The nonexistence of positive solutions for the above problem is also studied (see [1], [2]).

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Numerical solutions of the combined KdV-MKdV equation by a quintic B-spline collocation method

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In this paper, a numerical solution of the combined KdV-MKdV equation is obtained by a quintic B-spline collocation finite element method. In the solution process, a linearization technique has been applied to deal with the non-linear term appearing in the equation. The computed results are compared with those given in the literature. The error norms L_2 and L_∞ are computed and found to be sufficiently small. The Fourier stability analysis of the method is also investigated and found unconditionally stable.

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Asymptotic formulas for Sturm-Liouville operator with Coulomb potential

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Consider the singular Sturm-Liouville operator

$$L = -\frac{d^2}{dx^2} + \frac{1}{x} + q\left(x\right)$$

with domain $\{y \in L^2\left[0,1\right] : y, y' \text{ are absolutely continuous on } (0,1],\ Ly \in L^2\left[0,1\right] \text{ and } y\left(1\right) = 0\}$.

Let $\{\mu_n(q)\}_{n\geq 1}$ be the sequence of the eigenvalues of L. By Rouche's theorem there exits an integer N such that for every $n \geq N$ there is only one eigenvalue $\mu_n(q)$ in $\left\{\lambda \in \Re, \left|\lambda^{1/2} - \left(n + \frac{1}{2}\right)\pi\right| < \pi/2\right\}$. Our aim here is to find asymptotic formulas for this singular Sturm-Liouville operator with Coulomb potential.

Lemma 1 *For every f in $L^2\left[0,1\right]$,*

$$\int_0^1 \frac{\cos\sqrt{\mu_n(q)}\sin^2\sqrt{\mu_n(q)}t}{\mu_n(q)} f\left(t\right)dt = \frac{\cos\sqrt{\mu_n(q)}}{\mu_n(q)}\int_0^1 \frac{f\left(t\right)}{2}dt + O\left(\frac{1}{n^3}\right)$$

and

$$\int_0^1 \frac{\sin\sqrt{\mu_n(q)}\sin 2\sqrt{\mu_n(q)}t}{2\mu_n(q)} f\left(t\right)dt = O\left(\frac{1}{n^3}\right).$$

The main result of this paper is the following theorem:

Theorem 1 *For $q(x)$ in $L^2\left[0,1\right]$,*

$$\mu_n(q) = \left(n + \frac{1}{2}\right)^2\pi^2\left[1 + \frac{2}{\int_0^1 q\left(t\right)dt}\right]^2 + O\left(\frac{1}{n^4}\right).$$

Key Words: Rouche's theorem; Coulomb potential; asymptotic formula; eigenvalue

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A finite element method to solve the system of two-dimensional Burgers' equations

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In this paper, a Galerkin finite element method is proposed for numerically solving the system of two-dimensional Burgers' equations. The proposed method basically depends on two-dimensional Hopf-Cole transformation to convert the system of two-dimensional Burgers equations together with their initial and boundary conditions into a linear heat equation together with its corresponding initial and boundary conditions. The newly obtained linear heat equation is then solved by Galerkin finite element method using modified cubic B-spline base functions. Numerical experiments have been carried out to illustrate the applicability and efficiency of the proposed method.

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Solution of nonlinear singular boundary value problems using Polynomial-Sinc approximation

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A new highly accurate algorithm for the solution of nonlinear singular boundary value problems for ordinary differential equations is presented. The algorithm uses a collocation technique based on polynomial approximation at Sinc points.The scheme is tested for some nonlinear singular boundary value problems showing an exponential convergence rate. The examples are of second and higher order singular, nonlinear boundary value problems. For each example the error formula of the approximation is discussed and verified in a comparison of the analytic solution.

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Initial value problems in Quaternionic analysis

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Recently the initial value problem

$$\begin{aligned} \partial_t u &= \mathcal{L}u := \sum_{i=1}^{3} A^{(i)}(t,x)\partial_{x_i} u + B(t,x)u + C(t,x) \\ u(0,x) &= u_0(x) \end{aligned}$$

has been solved uniquely by N. Q. Hung [1] using the method of *associated spaces* constructed by W. Tutschke [2] in the space of generalized regular functions in the sense of quaternionic analysis satisfying the equation

$$\mathcal{D}_\alpha u := \mathcal{D}u + \alpha u = 0, \quad \alpha \in \mathbb{R}$$

where $\mathcal{D} = \sum_{j=1}^{3} e_j \partial_{x_j}$ is the DIRAC operator, and t is the time variable. Only sufficient conditions has been obtained in [1] for the operators $\mathcal{L}$ and $\mathcal{D}_\alpha$ to be associated.

In the present talk we will prove necessary and sufficient conditions for the underlined operators to be associated. This criterion makes it possible to construct all linear operators $\mathcal{L}$ for which the initial value problem with an arbitrary initial generalized regular function is always solvable. Further we will correct a mistake made in the calculation of the interior estimate in [1].

Key Words: Initial value problems, associated operators, quaternionic analysis, Dirac operator.

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Posters

International Conference on Nonlinear Differential and Difference Equations: Recent Developments and Applications (ICNDDE 2014), Antalya, Turkey, May 27-30, 2014.

On the oscillation theory on fractional calculus

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In this presentation, we shall give some new oscillation criteria on fractional calculus. In sequel, Riemann-Liouville, Caputo and Liouville fractional order derivative operators are used.

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Examples of Some Self-Similar Asymptotics for Porous Medium Type Equations

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In this presentation, we shall give some examples of some self-similar asymptotics for porous medium type partial differential equations of tumor angiogenesis .

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Estimation and convergence of a moving average

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We study the method of estimation, and under certain conditions it was the convergence of a moving average process. Let $\{y_i\ ,\ -\infty \prec i \prec +\infty\}$ be a doubly infinite sequence of identically distributed and dependent random variables . $\{a_i\ ,\ -\infty \prec i \prec +\infty\}$ be an absolutely summable sequence of real numbers. Let $X_n = \sum_{i=-\infty}^{\infty} a_i y_{i+n}$, $n \geq 1$, be the moving average process based on the sequence $\{y_i\ ,\ -\infty \prec i \prec +\infty\}$. As usual, we denote $S_n = \sum_{k=1}^{n} X_n$, $n \geq 1$, the sequence of partial sums. In my work we discuss the complete convergence of (Sn) under some suitable conditions. For example in the ϕ-mixing conditions, and also treat other types of convergence.

Key Words: Convergence, Moving average, ϕ-mixing .

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The boundary integral method for the Laplace equation with mixed and oblique conditions

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The solvability of the mixed and oblique boundary value problem is estabilshed by the Boundary Integral Equation method. Based on the Green formula, we express the solution in terms of the boundary data. The key to the realization of this method is to translate the tangential derivative to the fundamental solution. A system of boundary intregral equation of second kind Fredholm type is obtained. By the Fredholm and Riez thoerem, the existence and the uniqueness of the solution is established.

Key Words: Boundary integral equation method, Pseudo-differential operator, Tangential derivative.

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Existence of solutions for fractional four point boundary value problems with p-Laplacian operator

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In this paper, we are concerned with proving the existence of solutions for four point fractional diff erential equations with p-Laplacian operator. We obtain the existence of at least one solution for the problem applying Schauder fixed-point theorem.

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On Hyperbolic Function Solutions of Nonlinear Fractional Differential Equation

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The modified Kudryashov method is effective, powerful and can be used as an alternative to establish new solutions of di fferent type of fractional differential equations applied in mathematical physics. In this study, new traveling wave solutions have been constructed including hyperbolic function solutions and symmetrical Fibonacci function solutions of the space-time fractional Cahn Hillihard equation and the space-time fractional symmetric regularized long wave (SRLW) equation via modified Kudryashov method. Moreover, some of the solutions are described in the figures with the help of Mathematica.

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On a problem that models the growth of cancerous tumors

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In this work we propose to study a reaction diffusion quasi linear problem that models the growth of cancerous tumors. This problem is modeled by the following quasi linear problem:

$$\partial u/\partial t = \Delta u + F(u) \text{ in } \Omega \tag{1}$$

with the following boundary and initial conditions:

$$\begin{array}{l} u = \partial u/\partial x = 0 \text{ in } \Gamma \\ u(x,0) = u_0(x) \text{ with } x \in \Omega \end{array} \tag{2}$$

Where Ω is a bounded open domain in $\mathbb{R}^2$ and F is a positive function checking $F(0) = F(1)$. This type of problem models several phenomena in physics and biology as well as medicine, and other fields of nature. The special case where $F(u) = ku(1-u), k > 0$, this problem models the growth of cancerous tumors. We will then study the problem (1)-(2) for the case where to study this problem, we will use the decomposition of operators method, who cut the problem in two problems, which we will solve simultaneously. We will prove primarily a result of uniqueness of the solution. After we will study the existence of the solutions using a sequence of approximate solutions. Finally we will make a prior estimates, and we will study the convergence and we pass to take the limit. In the second part of this paper, we will make a numerical application.

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On discontinuous Dirac operator with eigenparameter dependent boundary and two transmission conditions

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In this paper, we consider a discontinuous Dirac operator with eigenparameter dependent both boundary and two transmission conditions. We introduce a suitable Hilbert space formulation and get some properties of eigenvalues and eigenfunctions. Then, we investigate Green's function, resolvent operator and some uniqueness theorems by using Weyl function and some spectral data.

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On integral representation for solution of generalized Sturm-Liouville equation with discontinuity conditions

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In this paper, some properties of kernel representation and integral representation of Jost solution are studied for Sturm-Liouville operators with diffusion potential which have discontinuity conditions inside a semi-interval.

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Integrability and normalizability for three-dimension analytic system

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In this poster, we examine the issues of normalizability and integrability for three-dimension analytic system. We relate here to the existence of the integrability, inverse Jacobi multiplier and monodromy maps.

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Eigenvalues for iterative systems of nonlinear boundary value problems

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In this paper, we determine the eigenvalue intervals of the parameters $\lambda_1,\ \lambda_2, \cdots, \lambda_n$ for which there exist positive solutions of the iterative systems of boundary value problems. Existence results are established via a fixed point theorem in a cone. As an application, we give an example to demonstrate our main results.

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On a certain impulsive differential system with piecewise constant arguments

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We study the existence of periodic solutions of a first order nonlinear impulsive differential system with piecewise constant arguments

$$\begin{aligned} x_1^{'}(t) &= \lambda x_1(t) - g(x_2[t-1]), \\ x_2^{'}(t) &= \lambda x_2(t) - g(x_1[t-1]), \quad t \neq k \in \mathbb{Z}^+ = \{1, 2, ...\},\ t \geqslant 0, \end{aligned}$$

$$x_1(t^-) = dx_1(t),\ x_2(t^-) = dx_2(t), \quad t = k \in \mathbb{Z}^+,$$

where $\lambda > 0$ is a real constant, $d \in \mathbb{R}\backslash\{0, 1\}$, $g : \mathbb{R} \to \mathbb{R}$ is a continuously differentiable function, $x_1(k^-) = \lim\limits_{t \to k^-} x_1(t)$, $x_1(k) = x_1(k^+) = \lim\limits_{t \to k^+} x_1(t)$, $x_2(k^-) = \lim\limits_{t \to k^-} x_2(t)$ and $x_2(k) = x_2(k^+) = \lim\limits_{t \to k^+} x_2(t)$, i. e. , $x_1(t)$ and $x_2(t)$ are right continuous at $t = k$ and [.] denotes the greatest integer function.

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Large time behavior of bounded solutions to a reaction-convection diffusion model estimating the number of bacteria in a river

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We present a convection-reaction diffusion model that refers to the quantification and the distribution of bacteria in a river. The !-limit set of the model is determined applying the theory of semigroups. Sufficient conditions for the existence of positive steady states are presented using Leray-Schauder's degree theory. Since, the emergence of antibiotic-resistant bacteria (ARB) in aquatic environments is a pressing public health problem; this model may be an intersting tool for understanding the bacteria's dynamics.

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Application of the extended trial equation method for nonlinear fractional differential equations

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Nonlinear fractional differential equations have many advantages in physical sciences and dynamic systems. In this study, exact solutions of the nonlinear fractional differential equations have been investigated. By using the extended trial equation method we have obtained analytical solutions of the nonlinear fractional Sharma-Tasso-Olver equation. Also, this method can be applied to other nonlinear fractional equations arising in mathematical physics.

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Centre bifurcations of limit cycles for three dimensional Lotka-Volterra systems

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We give lower bounds for the cyclicity of a hopf point in three dimensional Lotka-Volterra systems via centre bifurcations. Sufficient conditions for the existence of a centre are obtained via the Darboux method using inverse Jacobi multiplier functions. For a given centre, the cyclicity is bounded from below by considering the linear parts of the corresponding Liapunov quantities of the perturbed system. Although the number we obtain is not new, the technique is fast and can easily be adapted to other systems.

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Existence of symmetric positive solutions for a semipositone problem on time scales

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This paper studies the existence of symmetric positive solutions for a second order nonlinear semipositone boundary value problem with integral boundary conditions by applying the Krasnoselskii fixed point theorem. Emphasis is put on the fact that the nonlinear term f may take negative value. An example is presented to demonstrate the application of our main result.

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Some exact solutions to the Toda lattice equation

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We considered the Toda lattice equation

$$\ddot{u}_n = e^{u_{n-1}-u_n} - e^{u_n-u_{n+1}},\ n \in Z$$

and obtained some exact solutions to thet equation in terms of a triplet of constant matrices. To obtain such solutions in terms of a matrix triplet A, B, C we used the following steps:
1. Get the auxiliary matrix via

$$P - APA = BC$$

2. Form the auxiliary matrix via

$$\Gamma_n := I + e^{-t(A-A^{-1})}A^n P A^n,\ n \in Z,$$

3. Let

$$u_n := \log\det\left(\Gamma_n \Gamma_{n+1}^{-1}\right)$$

4. Then we provide that, u_n satisfies Toda lattice equation. Here matrices A, B, C have size $p \times p, p \times 1$ and $1 \times p$ respectively, for any positive integer p.
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Key Words: Exact solutions; Toda Lattice equation

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Exact solutions of some complex partial differential equations of fractional order

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In this paper we consider the fractional Schrödinger equation

$$i\frac{\partial^\alpha u}{\partial t^\alpha} + p\frac{\partial^2 u}{\partial x^2} + q\left|u\right|^2 u = 0, \tag{1}$$

and Eckhaus equation

$$i\frac{\partial^\alpha u}{\partial t^\alpha} + \frac{\partial^2 u}{\partial x^2} + 2\frac{\partial(|u|^2)}{\partial x}u + \left|u\right|^4 u = 0 \tag{2}$$

of order $0 < \alpha \leq 1$, with the initial condition

$$u(x,0) = e^{ix}u_0.$$

By using the variable transformation

$$u(x,t) = e^{ix}U(t), \tag{3}$$

these equations are reduced to ordinary fractional differential equations which provide us to find some exact solutions of these equations by using the Demirci and Ozalp's aproach. Demirci and Ozalp introduce a new technique to find the exact solutions of fractional differential equations by using the solutions of integer order differential equations.

Also we consider the fractional massive Thirring equations

$$\begin{aligned} i(\frac{\partial^\alpha u}{\partial t^\alpha} + \frac{\partial u}{\partial x}) + v + u\left|v\right|^2 = 0 \\ i(\frac{\partial^\alpha v}{\partial t^\alpha} - \frac{\partial v}{\partial x}) + u + v\left|u\right|^2 = 0 \end{aligned} \tag{4}$$

with the following conditions

$$\begin{aligned} u(x,0) = e^{ix}u_0 \\ v(x,0) = e^{ix}v_0 \end{aligned} \tag{5}$$

By using the same method, we obtain numerical solutions of this equation.

Finally graphics of some solutions are presented.

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Analysis of a two-component chemical reaction system with impulsive perturbations

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Behaviour of many real processes are generally modeled by ordinary differential equations and characterized by qualitative properties such as stability of the fixed points and existence of periodic solutions. However, evolution of a real process can be subject to short-term perturbations causing an instantaneous change in the state of the process. Many chemical reactions can be subject to sudden changes. We consider a two-component chemical reaction system perturbed by impulses and aim to investigate the dynamical behaviour of the system based on the parameters of the system.

Participants