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Mathematical Science and Its Applications

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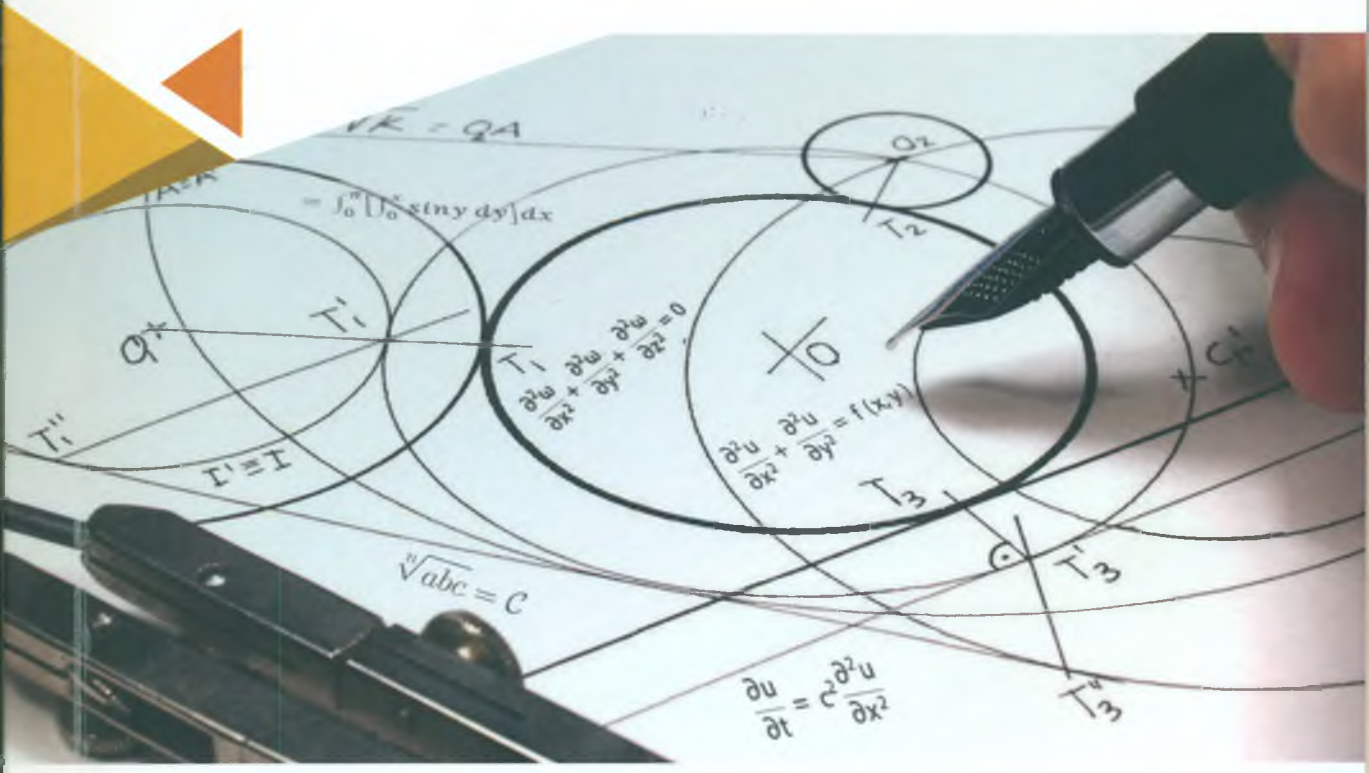
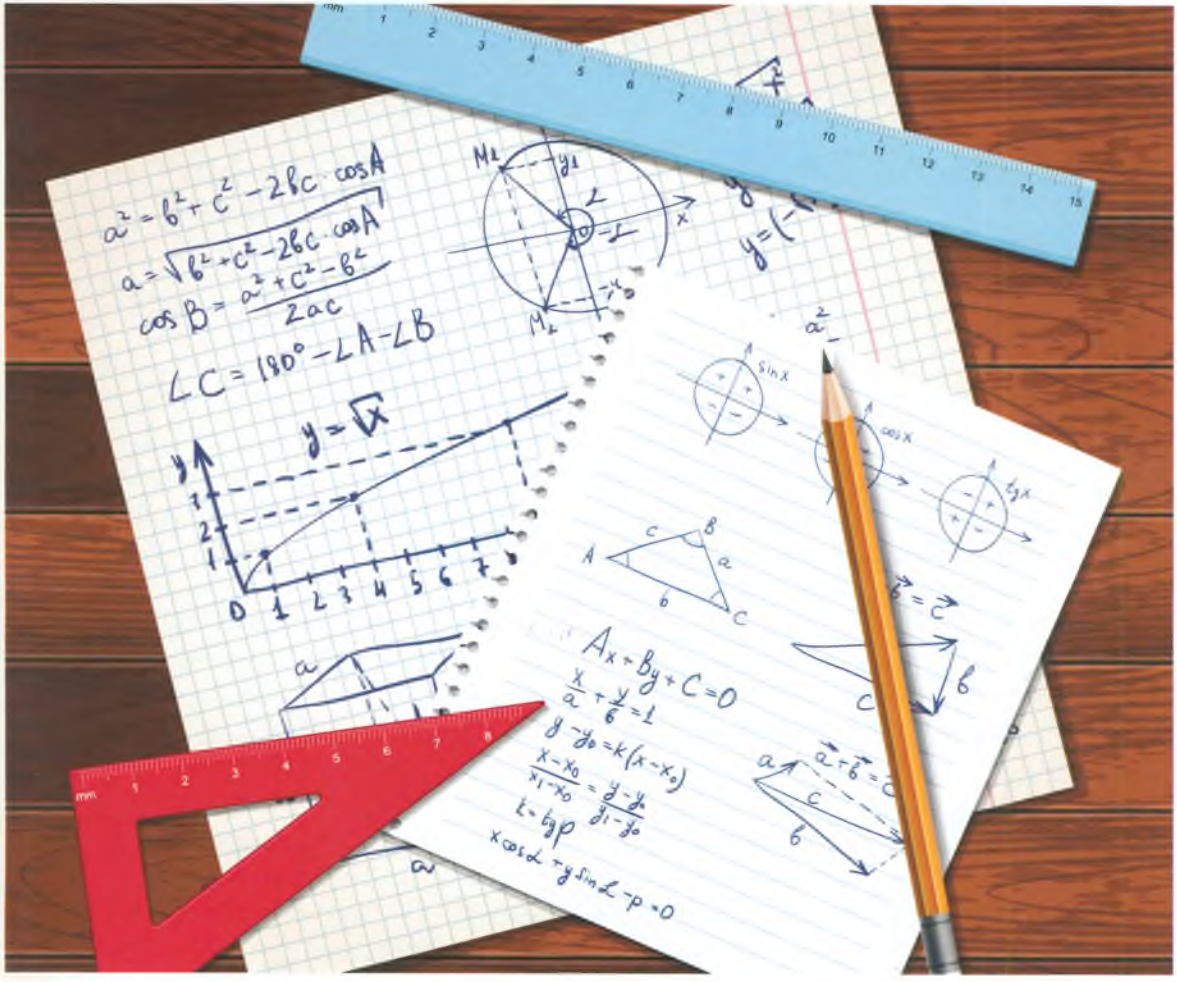
Abstracts Book



COLLEGE OF ARTS AND SCIENCES



Aims and Scope of the Conference:

The main aim of the conference is; to promote, encourage, cooperate, and bring together researchers in the fields of mathematical science and its applications. All areas of mathematical science will be represented with special emphasis on applications. Conference agenda formatted in such a way to be mathematically enriching and socially exciting. The interest areas of the conference include but are not limited to : Algebra(s) and Applications, Differential Equations, Approximation Theory, Calculus of Variations, Coding Theory, Combinatorics, Control Theory, Cryptology, Geometry, Difference and Functional Equations, Discrete Mathematics, Dynamical Systems and Ergodic Theory, Field Theory and Polynomials, Fluid Mechanics and Solid Mechanics, Fourier Analysis, Functional Analysis, Functions of a Complex Variable, Fuzzy Mathematics, Game Theory, Graph Theory, Group Theory and Generalizations, Integral Equations, Matrix Theory, Mathematical Biology, Mathematical Economics and Financial Mathematics, Mathematical Physics and Math Education.

Immersion Principle for a Two-Point Boundary Value Problem with Boundary Conditions

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In order to solve topical problems of natural sciences, technology, economy and ecology new mathematical methods allowing solving complex boundary value problems are needed. Mathematical models of management processes by nuclear and chemical reactors, control of electric power and robotic systems, economic management and others are complex boundary value problems of ordinary differential equations.

We consider a two-point boundary value problem with boundary conditions of the given convex closed sets. It is shown that the boundary value problems for a linear system of ordinary differential equations can be reduced to the corresponding initial value problems of optimal control. From the solution of the corresponding initial value problems of optimal control the solutions can be obtained: the boundary value problems with constraints, the boundary value problems with a parameter, construction of periodic solutions of autonomous systems. The basis of the proposed methods for solving boundary value problems with different constraints is a possibility of reducing these problems to a class of linear Fredholm integral equation of the first kind. Fredholm integral equation of the first kind belongs to the insufficiently explored problems in mathematics. Therefore, the fundamental research of integral equations and based on these solutions of boundary value problems of linear ordinary differential equations is a new promising direction in mathematics.

New Results for Čebyšev Fractional Type Inequalities

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New Čebyšev type inequalities for fractional Riemann-Liouville integrals are established. Our results are based on some fractional Montgomery identities.

Survey on Spline Wavelet and Its Applications

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We design a new family of orthogonal wavelet transforms that are based on polynomial and discrete splines. We mainly discuss and focus on the cubic spline, which is more practical in applications.

One of the challenging question for the researchers is that: to choose the most suitable form of the wavelet among the increasing variety of wavelet bases. Naturally, the choice of the "best" wavelet no doubt depends on application. Wavelet theory has been extensively studied in the recent years and has been widely applied in various areas throughout science and engineering. The wavelet analysis procedure is implemented with dilated and translated versions of a mother wavelet. In theory, the dilation (scale) parameter of a wavelet can be any positive real value and the translation (shift) can be an arbitrary real number. This in future is referred to as the continuous wavelet transformation. On the other hand, in practice to improve computational efficiency, the values of the shift and scale parameters are often limited to some discrete lattices. Then this is referred to as the discrete wavelet transform.

Splines have a significant impact on the theory of the wavelet transform. Spline wavelet is one of the most important wavelets in the wavelet family.

Splines have the best approximation properties among all known wavelets. In other words, they are the best for approximating smooth functions and have been used in many applications such as signal processing, image processing, mathematical physics, and numerical solutions of PDEs and so on.

On Solutions of Nonlinear Differential Systems

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We obtain uniform estimates from above and below of solutions of nonlinear systems of differential equations. These give an indication of the asymptotic stability of the zero solution of the nonlinear system of differential equations.

Green's Functions and American Options

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We use a classical Green's function approach to study American Options. Integral equations are derived for the location of the free boundary and an asymptotic expansion is used to find the location of the free boundary close to expiry. Using our results, we demonstrate that it is possible to replicate the American call with $r < D$ and the American put with $r > D$ with European options.

AMS Subject Classification: 91B28.
Key words: American options; Green's functions; asymptotics; free boundary.

Evolving Neural Network That Predicts Binary Classifier Accuracy

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In this paper, we describe the binary classification of textual messages using a combination of genetic algorithms and artificial neural networks. We first describe the problem of "news classification" and the method to gather the dataset samples used for artificial neural networks training and testing. We focus on creating and training a classifier based on a combination of different classifiers and model evaluation metrics. We choose three main attributes that affect text classifiers, and as a consequence affect the accuracy of classifiers. The first of the attributes are words on which it is built. We use an N-gram concept instead of words, where different N varies from one to five. The second attribute is a text pre-processing method, such as stemming and stop words filtering. The third attribute are classification method. In this research we choose the k-nearest neighbors and naive Bayes classification methods. A variation of these attributes produces various classifiers with various accuracy. As a result, we provide analysis of the correlation between classifier combinations and the accuracy of classifiers and we present evolving artificial neural networks that predict classifiers accuracy.

Keywords: binary classification, learning algorithms, evolving neural networks, neuroevolution.

Math Model in STEM Education

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In the past decade, there has been a particular interest in STEM education, especially when it is taught through effective teaching strategies to prepare students for STEM professions like scientists, technologists, engineers, and mathematicians (America, 2007).

Several studies have produced estimates of considering PBL as the best strategy to teach STEM (Mosier, Levine & Perkins, 2013; Asghar et al., 2012; Barnes & Barnes, 2005; Frykholm & Glasson, 2005; Loepp, 1999; Moseley

& Utley, 2006; Sage & Torp, 1997; Venville, Rennie & Wallace, 2004). However, there is still insufficient data especially in the United Arab Emirates about measuring to what extent using the PBL strategy in teaching higher education students STEM project will develop 21st-century skills in general and creative thinking skills in particular.

On October 19, 2014, Sheikh Mohammed bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE, launched a new strategy to make the UAE one of the world's most innovative nations within seven years (ValueInnovations, 2016).

"This innovation strategy is a national priority for our program of development and progress. It is a primary tool to achieve Vision 2021 and an engine for the growth of distinctive skills and capabilities across the nation. We have always called for creativity in every field: this strategy is a concrete step to implement that vision. These initiatives around innovation will enhance the quality of life in the UAE and take our economy to new horizons," Sheikh Mohammed bin Rashid Al Maktoum (ValueInnovations, 2016).

The strategy will be implemented along four parallel tracks. The fourth track will qualify individuals with highly innovative skills by concentrating on science, technology, engineering, and mathematics, including the creation of educational material for schools and universities (ValueInnovations, 2016).

The Higher Colleges of Technology (HCT) is an applied higher education institution in the United Arab Emirates. It aims to produce knowledgeable, innovative and skilled Emirati graduates that support the nation in pursuit of excellence. HCT is dedicated to the delivery of applied and vocationally focused programs through excellent instruction based on 'learning by doing' (HCT, 2012).

HCT Strategic Goals emphasize the following:

- Ensure all programs are applied in design and aligned with the philosophy of Learning by Doing.
- Make curricular and structural changes that emphasize our commitment to Learning by Doing.
- Elevate attention to innovation, creativity, and technology transfer.

Based on the researcher's experience in teaching at Higher Colleges of Technology, and the researcher's discussion with the program chairs of mathematics and engineering departments he found that,

- Students have a problem in applying what they learned in mathematics in engineering courses.
- Students have a serious problem in academic achievement in mathematics.
- There is a need to find a way to develop students' creative thinking skills to achieve HCT strategic goals and UAE vision.

STEM education is new in the UAE, and there are no researches done to measure the effectiveness of teaching math by using STEM project-based learning for students' creative thinking skills as well as how to integrate STEM into higher education. So, there is a need for STEM project-based learning teaching procedures that can be used in higher education, and there is a need to measure its effects in developing creative thinking skills and academic achievement.

The aim of integrated disciplines is to demonstrate a paradigm shift from the separate subject approach to teaching real-life problems (Capraro, Capraro, & Morgan, 2013) that require integrated knowledge from different disciplines to solve the problems collaboratively in a constructivism approach (Mayer, 2004)

The project-based learning (PBL) includes three types of learning that cut across the PBL: cognitive learning, content learning, and collaborative learning. By implementing these three categories in STEM education, the UAE Vision 2021 and HCT strategic goals will be met.

This paper will provide a model example of using STEM project-based learning approach in teaching mathematics.

The presentation will include a model example of math lesson and how to teach it.

Keywords and phrases: STEM Project-based Learning suggested approach, STEM Project-based Learning Procedures.

Modeling the Impact of Atmospheric Condition on the Evolution of the Pollutants' Concentration Series

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Nowadays the pollutants affect more and more the human health, especially due to their dissipation in the atmosphere. Therefore, maintaining them within reasonable limits is one of the major directions of the policies of the countries of sustainable development.

Modeling their dissipation is an important step in taking decision concerning the limitation of their impact on human life.

Therefore, in this article we present different models for the regional dissipation of some pollutants in Romania.

The proposed approach considers as exogenous variables the atmospheric factors and as an endogenous one, the pollutants' concentration.

Multi-Step Differential Transform Method for Solution of Hessenberg Index-3 DAEs

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Hessenberg higher-index differential-algebraic equations (DAEs) are frequently used to describe complex problems from applications. These DAEs are known to be difficult to solve due to their complex structure. Usually, such equations are first preprocessed by some transformations like index reductions before applying solution methods. However, one drawback of such transformations is that they can be computationally expensive and may lead to non-physical solutions.

In this paper, we propose an efficient method for the solution of nonlinear Hessenberg index-3 DAEs. This method is based on the multi-step differential transform method (DTM) and does not require any preprocessing step. Our algorithm accelerates the convergence of the series solution over large regions and improves the accuracy of the DTM. To demonstrate

the effectiveness and accuracy of the proposed technique, we implemented it in Maple to solve two nonlinear Hessenberg index-3 DAEs arising from mechanical systems.

Lie Superalgebras in Characteristic 2

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Coauthors: Alexei Lebedev, Dimitry Leites, Irina Shchepochkina

In this talk, we give a short introduction to the theory of Lie superalgebras in characteristic 2. Many of the definitions and concepts introduced are specific to the characteristic two case and have no analogue in higher characteristic. At the end, we introduce two procedures that to every simple Lie algebra assign simple Lie superalgebras. We prove that every simple finite-dimensional Lie superalgebra is obtained as a result of one of these procedures.

Permutation Polynomials of Degree 4 over Finite Fields

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Using elementary methods, we seek conditions on the coefficients of a polynomial of degree 4 which are necessary for it to represent a permutation over $\mathbb{F}_q$ where q is odd. We also give some results on polynomials which are not permutation polynomials over $\mathbb{F}_q$ and q satisfies some assumptions.

Keywords: finite fields, permutation polynomials.

Steady Laminar Boundary Layer Flow of a Class of Viscoelastic Fluids

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Boundary layer flows of viscoelastic fluids are encountered in a number of industrial and engineering applications. The constitutive equations of such fluids play an important role in the flow analyses. In this paper, we have investigated three-dimensional boundary layer equations of a special class of viscoelastic fluids, namely, second grade fluid. Similarity solutions of the BL equations have been considered assuming that such flows take place near a flat plate. It has been shown that similarity solutions can be obtained corresponding to two particular cases of the mainstream flow. Following a perturbation approach, there arises a set of nonlinear BVPs which have been solved numerically for one of these mainstream flows. The focus of this study is on seeking the influence of higher order terms in the perturbation expansion, and further to analyze the effects of non-Newtonian parameters — viscoelasticity and cross viscosity — on the flow.

The Existence of Local and Global Solutions to an Impulsive Semi-Linear Evolution Equation

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In this work, we establish the existence and uniqueness of local and global solutions for a nonlinear impulsive evolution system in Banach spaces X.

Multi-Grid Method Applied for Solving Electro-Viscoelastic Contact Problem with Friction

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In this work we present a mathematical model which describes the antiplane shear deformation of a cylinder in frictionless contact with a rigid foundation. The material is assumed to be electro-viscoelastic, and the friction is modeled with Tresca's law and the foundation is assumed to be electrically conductive. In this new work, we derive the classical variational formulation of the model which is given by a system coupling an evolutionary variational equality for the displacement field and a time-dependent variational equation for the potential field. In the second step, we prove the existence of a unique weak solution to the model. In the third step, we use the Multi-Grid Method for the discrete Problem (Ph). Finally, we prove the existence of a unique weak discrete solution to the model. In this case the algorithms will be presented at the end of this paper and some numerical results are illustrated.

Use of Intelligent Tutors in Mathematics Learning — Genderwise Similarity and Differences

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Intelligent tutoring software is developed by combining theories of cognitive science and techniques of artificial intelligence. The intelligent tutors can provide interactive and personalized learning environment for students

allowing them to study and learn individually. ALEKS is a web-based intelligent tutoring system, which is used in the higher education institutes to teach secondary and post-secondary mathematics courses. The name ALEKS is an acronym for Assessment and Learning in Knowledge Spaces, which indicates that this software provides learning opportunities through frequent formative assessments. Very little is known about how male and female students interact with such software and what their perceptions about use of such tools in learning mathematics are.

Purpose: The purpose of this paper is to investigate similarity and differences between male and female students' study habits and perceptions about learning mathematics using an intelligent tutoring software.

Context: This study is carried out in one of the higher education institutes in the United Arab Emirates. The target population consists of students studying in foundation year program. The intelligent tutoring software ALEKS is used as the main teaching tool in the chosen institute.

Design/methodology/approach: A cross-sectional study design is used. Total of 136 female students and 65 male students from the chosen higher education institute participated in the survey. A survey instrument is developed to measure students' study habits, patterns of interaction with the intelligent tutor and their perceptions about its effectiveness in learning mathematics. Paired sample t-test is applied to examine differences between their perceptions.

Findings: Results of paired sample t-test demonstrated that female students are more organized and follow systematic study habits more often than male students. No significant difference was found between their perceptions about using intelligent tutor in learning mathematics. A high percentage of students (72.6%) perceive that ALEKS is an effective tool to learn mathematics.

Originality and value: This empirical study is unique in the context of United Arab Emirates student population as well as in the context of an intelligent tutoring software.

Keywords: intelligent tutor, ALEKS, mathematics education.

Solution of the Cauchy Problem for Parabolic Pseudodifferential Equations with a Small Parameter in the Forward and Backward Time

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It is well known that the system of Newton equations describing the dynamics of particles (molecules) is reversible in time. On the other hand, the heat conduction equation, which is, in a sense, the limit of the system of equations describing the motion of particles, does not have such a property. We will consider pseudodifferential equations of parabolic type (a special case of such equations is the heat conduction equation with a small parameter at the highest-order derivative). We consider the class of solutions with the logarithmic limit which is the viscosity solution of the corresponding Hamilton-Jacobi equation. It turns out that such a class of functions is invariant under the action of the semigroup corresponding to the equation. Moreover, in a certain weak sense, the solution of the Cauchy problem in this class of functions is reversible in time, *i.e.*, the semigroup understood in this sense becomes a group.

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Integral Boundary Value Problems for Singularly Perturbed Differential Equations

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In the works of M.I. Vishik, L.A. Lyusternik [1] and K.A. Kasymov [2] initial value problems for singularly perturbed nonlinear equations of the second order with unbounded initial conditions when the small parameter tends to zero were first studied. These problems are called Cauchy problems with an initial jump. A characteristic feature of these problems is that the solution of singularly perturbed problems tends to the solutions of the degenerate equations with the changed initial conditions. In this case, we say that there is a phenomenon of the initial jump of the solution. 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 were studied by K.A. Kasymov.

This work is devoted to the asymptotic behavior of the solution of two-point integral boundary value problems for linear differential equations of the third order with the small parameter at the two highest derivatives when the roots of the additional characteristic equation have opposite signs.

The asymptotic estimation of the solution of the integral boundary value problem is obtained. Derivatives of the solution at the ends of the interval become infinitely large for sufficiently small values of the parameter. The results obtained show that the solution of the integral value problem on both sides of the given segment has the initial jumps with different orders. In this case, we say that there is a phenomenon of the boundary jump.

The two-point boundary value problems for linear differential and integro-differential equations were investigated in [3,4] and others.

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Existence of Solutions for Irregular Boundary Value Problems of Nonlinear Fractional Differential Equations

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In this work, we study the existence, uniqueness and continuous dependence of solutions for a nonlinear boundary value problem associated with a fractional differential equation. More precisely, we have studied a boundary value problem associated with a fractional differential equation involving mixed and nonhomogeneous boundary conditions and a nonlinear term dependent on the fractional derivative of the unknown function.

Numerical Modelling of Liquid Filtration Process at the Area near Well Zone of Seam

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A mathematical model of filtration theory which describes filtration processes of a two-phase fluid flow at the area near well zone of seam is investigated in this paper. Some effective and economical computational algorithms are suggested too. Prognosis calculations with real data of concrete geological field of Kazakhstan West region are considered in this article.

The main result of this work is the selection of depression curve in finite time and exact solution fast obtained. Time steps were selected adequately small for the iterations to converge. The results of calculations are in consent with the described conclusions (results).

Keywords: depression curve, the area near well zone of seam, seam pressure, convergent iterations.

Statistical Analysis: Mediator vs. Moderator

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The research intended to defining and clarifying dissimilarities in the use of either of the moderator or mediator variables implemented in a conceptual model. In the case of receiving the Outstanding Scientist Award VIFRA 2015 in the field of statistics, I wish to point part of my success to provide a literature review paper for scientists about the correct methods that should be followed in order to use a moderator or mediator variable in a certain conceptual model. Different technical ways were involved to detect the utilization of the two variables in a certain proposed model. This study reconsidered different scholarly literatures in measuring the moderator and mediator variables. Mediator variables have a tendency to extenuate the relationship between variables while the Moderator variable merely expresses the causal relationship between variables in a conceptual model. The literature indicated that

there are certainly significant differences between these variables. If statistical forecasters fail to recognize the dissimilarity of the two variables or if these two are used interchangeably, the outcomes will be prone to statistical errors. This study determined that it is useful for analysts to identify with the degree of employing the two variables.

Quasi-Nonexpansive Multivalued Mappings in CAT(0) Spaces

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In this paper, by an iterative method, we find a common fixed point of a finite family of quasi-nonexpansive multivalued mappings in CAT(0) spaces.

Fractional Boundary Value Problems on the Half-Line

Assia Frioui
08 May 1945 Guelma University
Coauthors: Assia Guezane-Lakoud and Khaldi Rabah

In this paper, we focus on the solvability of a fractional boundary value problem at resonance on an unbounded interval. By constructing suitable operators, we establish an existence theorem upon the coincidence degree theory of Mawhin.

Poisson Quasi-Lindley Distribution

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This paper proposes a recent version of compound Poisson distributions named Poisson quasi-Lindley (PQL) distribution by compounding Poisson and quasi-Lindley distributions. Some properties of the distributions are given with estimation and some illustrative examples.

Keywords: Lindley distribution, Poisson distribution, Poisson-Lindley distribution, Gamma Lindley distribution, maximum-likelihood estimation.

Perpetual Put Options with Transaction Costs and a Nonlinear Black-Scholes Equation

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We are concerned with a financial put option with no fixed maturity and no exercise limit, in which the volatility depends on gamma. This leads to the study of a stationary nonlinear Black-Scholes equation, more precisely, to the analysis of a free boundary problem where we present a solution of an ordinary differential equation and implicit equation for the free boundary position. A motivation for addressing nonlinear Black-Scholes problems arises from option pricing models including, for instance, non-zero transaction costs, investors preferences, feedback and illiquid markets effects and risk from unprotected portfolio.

Existence of Solutions for a Nonlinear Higher Order Fractional Differential Equation

Assia Guezane-Lakoud
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Coauthor: Khaldi Rabah

In this talk, we discuss new results regarding the existence of solutions for a nonlinear higher order fractional differential equation involving both Riemann-Liouville and Caputo fractional derivatives with a natural boundary condition. The study is based on the upper and lower solutions method and on the monotonicity of the Caputo derivative.

Orbital Measures on $SU(2)/SO(2)$

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We let $U = SU(2)$, $K = SO(2)$ and denote by $N_U(K)$ the normalizer of K in U. For a an element of $U \setminus N_U(K)$, we let μ_a be the normalized singular measure supported in KaK. For p a positive integer, it was proved in [1] that $\mu_a^{(p)}$, the convolution of p copies of μ_a, is absolutely continuous with respect to the Haar measure of the group U as soon as $p \geq 2$. The aim of this paper is to go a step further by proving the following two results: (i) for every a in $U \setminus N_U(K)$ and every integer $p \geq 3$, the Radon-Nikodym derivative of $\mu_a^{(p)}$ with respect to the Haar measure m_U on U, namely $d\mu_a^{(p)}/dm_U$, is in $L^2(U)$, and (ii) there exists a in $U \setminus N_U(K)$ for which $d\mu_a^{(2)}/dm_U$ is not in $L^2(U)$, hence a counterexample to the dichotomy conjecture stated in [2]. Since $L^2(U) \subseteq L^1(U)$, our result gives in particular a new proof of the main result in [1] when $p > 2$.

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On an Elliptic System Involving Critical Sobolev Exponent and Weights

Yamina Hamzaoui
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This work is devoted to the existence and nonexistence of positive solutions for a semilinear elliptic system involving critical Sobolev exponent and weights. We study the effect of the behavior of weights near their minima on the existence of solutions for the problem considered.

Irregular Total Labellings of Möbius Ladder M_n

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The total edge irregularity strength tes(G) and total vertex irregularity strength tvs(G) are invariants analogous to irregular strength $s(G)$ of a graph G for total labellings. Baca et al. determined the bounds and precise values for some families of graphs concerning these parameters. In this paper, we show the exact values of the total edge irregularity strength and total vertex irregularity strength of Möbius Ladder M_n.

Keywords: irregular total labelling; Möbius Ladder; total labelling.

On Parabolic Approximation for Inhomogeneous Viscous Incompressible Fluid

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A system where an incompressibility equation is approximated by a parabolic equation with respect to pressure for inhomogeneous fluid is considered. A theorem of existence of a solution is proved. An exact estimate of convergence of the approximate solution to the solution of the initial value problem is given.

Development of a Mathematical Model of Filtration Theory with Phase Transitions

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The mathematical model of non-equilibrium filtration in axisymmetric formulation is investigated in the paper. The method of phase field is used for the analysis of the process of two-phase fluid filtration in the porous media. This method is one of the options to define the changes of interfaces between two media (the interface between water and oil). It is believed that the interface has a finite thickness and is characterized by a smooth change of density, velocity, and other technological parameters. For switch between phases, instead of saturation, a dimensionless function of the phase indicator is introduced. Then the phase indicator is determined by the Cahn-Hilliard equation. In the calculations, a two-dimensional axisymmetric model, including the system of Stokes equations for two-phase flow of an incompressible fluid and the heat equation, is used.

Numerical Investigation of the Thermal-Mechanical Rod State of a Heat-Resistant Alloy in the Presence of Temperature and Heat Exchange

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Coauthor: Anarbay Kudaykulov

The paper defines the law of temperature distribution along the length of the test rod at different temperatures. In these alloys, thermal expansion coefficient is strongly dependent on temperature.

Intensive development of advanced processes in the area of metallurgy creates favorable conditions for the production of improved high-temperature alloys with high resistance to plastic deformation and damage from exposure to high temperatures. The importance of production of such products is due primarily to the fact that the heat-resistant alloys are widely used in missile and aircraft engine, gas turbine power plants, refineries constructions, in the steam generators of nuclear reactors, as well as for the manufacture of parts of turbine installations and internal combustion engines.

Keywords: temperature, discrete element, heat exchange, thermomechanical rods.

Numerical Analysis of an Inverse Problem for a Pseudoparabolic Equation

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In this work an inverse problem for a pseudoparabolic equation is considered. By the successive approximations method numerical solutions are obtained.

The Dirichlet Problem in a Cylindrical Domain for Multidimensional Hyperbolic Equations with Degeneracy of Type and Order

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In this paper we show the solvability of the Dirichlet problem in a cylindrical domain for multidimensional hyperbolic equations with degeneracy of type and order.

Overlapping Nonmatching Grid Method for the Ergodic Control Quasi-Variational Inequalities

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In this paper, we provide a maximum norm analysis of an overlapping Schwarz method on nonmatching grids for a quasi-variational inequalities related to ergodic control problems studied by M. Boulbrachène, where the 'discount factor' (*i.e.*, the zero order term) we use an overlapping Schwarz method on a nomatching grid which consists in decomposing the domain in two subdomains, where the discrete alternating Schwarz sequences in the subdomains converge to the solution of the ergodic control IQV for the zero order term. For $\alpha \in]0,1[$ and under a discrete maximum principle we show that the discretization on each subdomain converges quasi-optimally in the L_∞ norm to 0.

Conjugate Method for Variational Inequality Problems over Fixed Point Sets

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In this paper we consider a variational inequality problem VIP(F, Fix$T$), where F, T are mappings from a real Hilbert space into itself and Fix$T$ is the fixed points set of a demicontractive mapping T. To find an approximate solution we propose an iterative algorithm given as:

$$x_{n+1} := (1-\omega)v_n + \omega T v_n, \qquad v_n := x_n - \alpha_n F(x_n).$$

Under some assumptions on F, T, ω and $\{\alpha_n\}$ we establish strong convergence of the sequence $\{x_n\}$ generated by this scheme for the solution of VIP(F, Fix$T$). An application to convex minimization is provided.

Keywords: demicontractive mapping, conjugate, gradient, proximinal space, fixed point sets.

AMS Subject Classifications: 49B22, 49J20, 35J65.

Asymptotic Behavior of the Solution of BVP for an Integro-Differential Equation with a Small Parameter in the Highest Derivatives

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The present work is devoted to the study of the asymptotic behavior of the solution of a boundary value problem with initial jump for a linear integro-differential equation of high order with a small parameter in the highest derivatives. In this paper for a singularly perturbed homogeneous differential

equation of high order a fundamental system of solutions is constructed. With the fundamental system of solutions a Cauchy function and boundary functions are constructed. Using the Cauchy function and the boundary functions an explicit analytical formula for the solution of the considered local boundary value problem for the singularly perturbed integro-differential equation of high order is obtained. A theorem about asymptotic estimation of the solution of the boundary value problem is proved.

Similarly, a boundary value problem for an ordinary differential equation was considered in [1]. In the particular case $m = 2$ and $l = 2$, a boundary value problem for a singularly perturbed integro-differential equation was similarly considered in [2, 3].

Key words: singular perturbation, small parameter, boundary functions, Cauchy function, initial jump.

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Introduction to the Z-Transforms and Engineering Applications, a Survey

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We introduce the basic theory of Z-transforms, provide numerical examples and answer the question what are the benefits and advantages of using transforms in the solution of discrete systems. As it is well known, Laplace transform is commonly used for solving and analyzing linear ordinary differential equations and system of linear ODE, likely the Z-transform method is the most suitable for linear difference equations and systems of linear difference equations. Such sort of solutions are related with analyzing and designing of digital control, communication, and signal processing. The Z-transform is simply a power series representation of a discrete-time sequence.

Development of an Automated System for Optimal Management of Oil Production

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The work is dedicated to the development and research of methods of mathematical and computer modeling of fluid flow filtration process in porous media. It substantiates various approximate methods for solving the multiphase fluid filtration theory and shows the structures of building a system of automated analysis, monitoring and forecasting of technological parameters of oil and gas development.

The main objective of the work is to construct a mathematical model of the object, i.e., a formalization of the object's functioning laws, based on the structure and parameters of the system, the control law is determined, a hardware implementation is selected. This is due to the increased role of mathematical modeling and computational experiment for the discovery

of these laws, and the study of complex phenomena. The relatively recently developed structural theory of distributed systems makes it possible to study the behavior of objects in their mathematical models. In the oil and gas field development system the next part of the overall production process is a sequence of physical processes of gas filtration, condensate, water in the porous permeable formation and movement of these components in wells. Over 20 years researches on the development of automated systems of oil and gas fields have been conducted, which are designed for the specialists of the oil industry of the Republic of Kazakhstan.

In the paper the following basic mathematical problems are studied:

1. To determine the solvability of a mathematical model of nonequilibrium filtration, describing the process of oil displacement by polymer solutions.

2. To prove the correctness of the mathematical model and properties of solutions based on phase transitions.

3. Justify the fictitious domain method for solving problems of the theory of filtration.

4. Develop a comprehensive program for the evaluation of changes of technological parameters of the deposit.

Mathematical and Numerical Simulation of a Liquid Filtering Process in a Porous Medium

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The work is devoted to the description of the process of fluid filtration in porous media with phase transitions. The corresponding mathematical model is a sophisticated version of problems such as Stefan's and Verigin's. The boundaries between the subdomains are free (unknown), and shall be determined in the process of solution of the corresponding mathematical problem. The numerical algorithm for the numerical implementations and

test cases to describe the motion of a fluid in a porous medium are built. A comparative analysis with the real processes of a particular field is carried out. Test examples show that the construction of a mathematical model can be used to forecast calculations. At the same time by the history of development options to adapt the model are studied.

Investigating Hydrochemistry and the Groundwater Quality Prospects Evaluation and Its Suitability for Agricultural, Tabuk, Jauf and Hail Regions, Saudi Arabia Using Descriptive

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The current study emphasizes on the hydrochemical evaluation of groundwater in the Northwestern part of Saudi Arabia and particularly in Tabuk, Jauf and Hail regions. In these regions, the aquifers appear as confined aquifers. The main aquifer has extensive outcrop areas along the boundary with the Arabian Shield in the west, where it receives some recharge which is less than the volumes abstracted from the aquifer. Groundwater samples were gathered from about 60 groundwater wells and tested for various physico-chemical parameters such as electrical conductivity (EC), pH, temperature, total dissolved solids (TDS), Na^+, K^+, Ca^{2+}, Mg^{2+}, CO_3^{2-}, HCO_3^-, Cl^-, SO_4^{2-}, and NO_3^-. Groundwater in the area is slightly alkaline and hard in nature. Electrical conductivity (EC) varies between 171 and 5061 μS/cm with an average value of 982μS/cm. The distribution of major ions in the groundwater is $Ca^{++} > Na^+ > Mg^{++} > K^+$ and $Cl^- > SO_4^{2-} > HCO_3^-$. Using Pipers classification, groundwater was classified under Na-C-SO_4 water type. The GW has acquired unique chemical characteristics through prolonged rock water interactions, percolation of irrigation return water and reactions at vadose zone.

Keywords: hydrochemical classification, water quality, nitrate pollution, Saq aquifer, Saudi Arabia.

Asymptotical Representation of Singularly Perturbed Boundary Value Problems for Integro-Differential Equations

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Abstract

We consider the two-point boundary value problem for the singularly perturbed higher order linear integro-differential equation. An asymptotic in a small parameter representation of the solution is obtained. It is shown that the solution has the phenomenon of the m-th order initial jump at the point $t = 0$.

Keywords: singular perturbation, integro-differential equations, small parameter, initial jump.

Introduction

The present work is devoted to the research of the asymptotic in the small parameter behavior of solutions of the unseparated two-point boundary value problem for a singularly perturbed linear integro-differential equation of n-th order with integral terms of Fredholm type. We have that the solution of the boundary value problem has an m-th order initial jump at the point $t = 0$. Boundary value problems for singularly perturbed integro-differential equations of higher order with the initial jump of the m-th order were considered in [1].

For a nonlinear ordinary differential equation of the second order with a small parameter the initial value problems with singular initial conditions were studied by M. I. Višik and L. A. Lyusternik [2] and K. A. Kasymov [3]. They found that the solution of the original initial value problem tends to the solution of the degenerate equation with different initial conditions, when

the small parameter approaches zero. Such problems became known as the Cauchy problems with initial jump. The most general cases of the Cauchy problems for singularly perturbed nonlinear systems of ordinary differential and integro-differential equations, as well as for partial differential equations of hyperbolic type were studied by K. A. Kasymov [4, 5].

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A New Approach to Means' Inequalities

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Means and their inequalities have attracted researchers, due to their applications in different areas of mathematics. The main goal of this work is to present recent advances in this topic. In particular, we describe a new approach to refine and to reverse some well-known inequalities like Young's inequality, Heinz inequality, the arithmetic-harmonic and geometric-harmonic

mean inequalities. We discuss these inequalities in view of convexity and interpolation.

Stabilization of a Viscoelastic Beam Conveying Fluid

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In this work, vibration reduction of a viscoelastic flexible beam with time-varying internal fluid is studied. Boundary control is designed at the top boundary of the beam based on an original infinite-dimensional PDEs model and Lyapunov's direct method to reduce the beam's vibrations. The uniform stability under external disturbance and exponential stability without external disturbance are proved based on the proposed boundary control.

Estimates of Solutions of a Problem of Electrodynamics Arising in Magnetohydrodynamics in Functional Spaces

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In this paper we establish estimates of solutions in Sobolev and Hölder spaces for solutions of the linearized problem of magnetohydrodynamics for the magnetic field. The result can be useful for studying nonlinear problems in magnetohydrodynamics, in particular, the problem with unrestricted boundary.

Urgent Problems of Working out the School Course of Mathematics Meet the Modern Requirements

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The article discusses the structure, content and originality of the textbook "Algebra and Mathematical Analysis of the Beginning" for the 10th and 11th grades of natural-mathematical analysis of secondary schools and the direction of the content of the textbook problems for training and development of the student.

Keywords: textbook algorithm, mathematical modeling, functional and graphical representation, curriculum, logical thinking, creative activity.

Numerical Modelling of Two-Phase Incompressible Liquid Filtration with Capillary Forces

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At present secondary methods in oil fields gain in importance, the main of which is ousting the oil by the water — a flooding method. In this connection, the role of mathematical modelling of two-phase incompressible liquid filtration processes increases. This paper's task is theoretical and numerical research of mathematical models of two-phase incompressible liquid filtration describing the process of oil production with water blowing. Based on a priori evaluation theory a possibility of use of a method of fictitious domains for filtration problems has been proved and unimproved evaluations of the convergence speed of an auxiliary problem solution to the initial problem solution have been achieved. A mathematical model has been proposed, an algorithm has been created and numerical experiments for solution of two-dimensional

and three-dimensional problems of two-phase incompressible liquid filtration with capillary forces have been carried out.

Risk Assessment Using the Analysis of Loss Distribution

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While assessing the amount of insurance claims there is often a situation in which the maximum amount of payments to the policyholder cannot exceed the policy limit. In other words, the empirical insurance claims data represents a right-censored sample with a truncation at the policy limit. Such payments are called censored on the right as information on the amount of insurance compensation above the policy limit is truncated on the right.

In the case of censoring, standard statistical procedures for determining the distribution, calibration exercises, and the comparison of independent samples need to be significantly modified. It should be noted that processing of such data usually requires use of numerical approximation methods. This is not only due to the large volume of the data being analyzed, but also because of the functional form of the model that is being optimized.

This article considers methodical foundations of estimation of loss distribution and estimation of distribution of parameters in the right-censored data. Also, a comparative analysis of the results obtained and the calibration of loss distribution that describes the development of the losses was done.

Key words: risk assessment, censored data, loss distribution.

On Stationary Solutions of the Problem of Two Stationary Radiating Centers

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The problem of particles motion in the field of two stationary radiating centers is considered. In such an extended formulation, the problem favorably differs from the corresponding classical problem by the fact that in the case of fixed centers there are components of a binary star, taken for material points. Necessary and sufficient conditions for the existence of a three-parameter family of stationary solutions are found. The necessary conditions for Lyapunov stability are obtained and the stability domain of the family of solutions is constructed. It is proved that on a certain manifold the points under consideration are stable in a strict nonlinear formulation. At stable points, the cluster of gas-dust clouds in the interstellar medium of binary stellar systems is expected.

Keywords: stationary center, particle, stationary solutions, gas-dust clouds, radiation, photogravitational field, cluster, stability, binary star.

The Investigation of the Nonlinear Free Problems of the Filtration Theory

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The work is devoted to the investigation of the solvability of the nonlinear one-dimensional free boundary problems describing fluid motion in porous medium with regard for pressure and temperature.

For the one-phase problem of Stefan type for a nonlinear parabolic equation the solvability in Hölder function spaces was proved and the asymptotic behavior of the solution was studied. The existence of the solution for the free boundary problem for the system of nonlinear parabolic equations was established. The existence and uniqueness in Hölder spaces of the solution for

Stefan type problem with melting temperature depending on the unknown pressure were proved, coercive estimates for the solution were obtained.

Boundary Value Problem for a Class of Nonlinear Second Order Ordinary Differential Equations

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In this presentation the existence of continuous solutions of a two-point boundary value problem in an interval of the positive real line for a class of nonlinear second order ordinary differential equations with variable coefficients is proved. To prove the existence theorem about the two-point boundary value problem the author constructed the general solution of the corresponding linear second order differential equations with variable coefficients and used the Schauder fixed point principle. The method of construction of the solution of the linear second order differential equations with variable coefficients and the general solution can be useful for various applications of science. For simplicity the coefficient and the nonlinear part of the ordinary second order differential equation are taken from the space of measurable and essentially bounded functions. One can easily verify that the results remain in force also in this case.

(Weighted) Composition Operators between Besov Type and Bloch Spaces

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In this article first by using the hyperbolic analytic Besov type class we characterize bounded and compact composition operators from Bloch to Besov type spaces. Also we give some conditions for weighted composition

operators from Besov type to Bloch spaces to be bounded or compact.

Keywords: Besov type space, Bloch space, hyperbolic analytic Besov type class, weighted composition operator.

MSC 2010: 47B33, 30H25, 30H30.

Ultimate Bound and Dynamical Behavior for a New Complex Financial Chaotic System

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In this paper, a dynamic complex financial system is proposed for the first time. The boundedness of the solutions of this system is concerned. We have obtained the ultimate bound for the system. Furthermore, its rich dynamics are investigated through numerical simulations. By using the Lyapunov exponents technique, it is found that the variation of system parameters can induce the parameter ranges of chaos are different. Finally, numerical simulations are given to verify the effectiveness and correctness of the results obtained.

On the Application of Quasi-Conformal Mappings to Solve the Problem of Filtration Theory

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The work is devoted to the application of quasi-conformal mappings to solve the mathematical model of isothermal filtration theory. An advantageous moment is the transformation of domains with non-smooth free (unknown) boundaries in the upper half-plane. Numerical calculations and comparative analysis with known results are given.

Keywords: quasi-conformal mappings, filtration processes, non-smooth boundaries, upper half-plane.

A Collocation Method of Solution of One-Dimensional Linear Hypersingular Integral Equation

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An approximate solution of a one-dimensional linear hypersingular integral equation on a closed interval by the spline-collocation method is constructed. Sufficient conditions for the existence of an approximate solution and an estimate of the approximation are obtained.

Modeling the Fluid Filtration in a Deformable Transversally-Isotropic Medium with Multilateral Horizontal Wells

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The mathematical model of oil filtration is simulated in a deformable transversely-isotropic medium. The numerical solution of the filtration's model is carried out using the finite element method.

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