RECENT RESEARCHES in APPLIED MATHEMATICS

15th WSEAS International Conference on APPLIED MATHEMATICS (MATH '10)

Vouliagmeni, Athens, Greece
December 29-31, 2010

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Preface

This year the 15th WSEAS International Conference on APPLIED MATHEMATICS (MATH '10) was held in Vouliagmeni, Athens, Greece, December 29-31, 2010. The conference remains faithful to its original idea of providing a platform to discuss linear algebra and applications, numerical analysis and applications, differential equations and applications, probabilities, statistics, operational research, optimization and applications, algorithms, discrete mathematics, systems, communications, control, computers, education etc. with participants from all over the world, both from academia and from industry.

Its success is reflected in the papers received, with participants coming from several countries, allowing a real multinational multicultural exchange of experiences and ideas.

The accepted papers of this conference are published in this Book that will be indexed by ISI. Please, check it: www.worldses.org/indexes as well as in the CD-ROM Proceedings. They will be also available in the E-Library of the WSEAS. The best papers will be also promoted in many Journals for further evaluation.

A Conference such as this can only succeed as a team effort, so the Editors want to thank the International Scientific Committee and the Reviewers for their excellent work in reviewing the papers as well as their invaluable input and advice.

The Editors

Table of Contents

Plenary Lecture 1: Investigation and Numerical Solution of System of Nonlinear Integro-Differential Equations Associated with the Penetration of a Magnetic Field in a Substance 11
Temur Jangveladze

Plenary Lecture 2: On some finite difference methods for systems of multidimensional equations of parabolic type with partial derivatives 13
Hamlet Meladze

Plenary Lecture 3: On Mathematical Models and Numerical Algorithms for Solution of Some Problems of Water Pollution 14
David Gordeziani

Plenary Lecture 4: Statistical Inference for Shannon and Renyi Information 16
N. N. Leonenko

Solution of Equation by Using Difference Formulas 17
Hamideh Eskandari

An Exact Solution Procedure for Mode Identity and Resource Constrained Project Scheduling Problem 20
Behrouz Afshar Nadjafi, Amir Rahimi

Solving the Stochastic Capacitated Location-Allocation Problem by Using a New Hybrid Algorithm 27
Esmaeil Mehdizadeh, Mohammad Reza Tavarroth, Seyed Mohsen Mousavi

Estimate of the Spectral Condition Number of Multigrid Preconditioner for Hirarchical Triangular Grids 33
Amir Ranjbar

Linear Stability of a Convective Flow in a Vertical Pipe 44
A. Kolyshkin, R. Vaillancourt

A Three Day Versus a Five Day Graphing Handheld Professional Development Program; and, its Attitudinal Effect on Teachers of Mathematics 49
Gail M. Gallitano, Kathleen Jackson

On Asymptotic Behavior and Numerical Resolution of One Nonlinear Maxwell's Model 55
Zurab Kiguradze

Predicting Model of Mathematics Problem Solving: The Role of Achievement Goal & Self-Regulation Strategies 61
Parvin Kadivar, Dasta M., Jvadi Sh., Farzad V.

Theoretical Considerations Regarding Spare Parts Reliability Evaluation Based on an Integrated Management System 67
Marin Silviu Nan, Dumitru Jula, Constantin Nicolescu, Cornelia Bolovan Belingher, Gabriel Valentin Voicu, Grigorie Petre

ISBN: 978-960-474-263-9

A Note on Derivations of Commutative Rings 73
Michael Gr. Voskoglou

Investigation and Numerical Solution of System of Nonlinear Integro-Differential Equations Associated with the Penetration of a Magnetic Field in a Substance 79
Temur Jangveladze

Discussions on Applied Mathematics in Decision-Making Modeling with Decision Support Systems and Knowledge Based Systems 85
Sabina-Cristiana Necula

Discussions on Qualitative Assessment or Risk Quantification in Adopting Decisions Concerning Risk in Financial Auditing 91
Diana-Laura Radu, Sabina-Cristiana Necula

Creating Semantic Relations for User Manuals on Semantic Web Using SKOS 97
Simona-Elena Varlan

On the Distribution of Zeros for Daubechies Orthogonal Wavelets and Associated Polynomials 101
Jalal Karam

On One Nonlinear Two-Dimensional Diffusion System 105
Temur Jangveladze, Maia Nikolishvili, Besik Tabatadze

Applying of Mathematics Methods in Decision Taking Process Concerning Replacement of Machines and Equipments Used in Flexible Manufacturing Cells 109
Ioan Constantin Dima, Janusz Grabara, Mariana Man, Ioana Raluca Goldbach

On Decomposition Methods and Variational Formulation for Bitsadze-Samarskii Nonlocal Boundary Value Problem for Two-Dimensional Second Order Elliptic Equations 116
Temur Jangveladze, Zurab Kiguradze, Giorgi Lobjanidze

The Dynamics of a Class of One-Dimensional Chaotic Maps 122
Sen Pei, Zhiming Zheng

Analysis of Complexity in Interacting Diffusion Systems by Entropy Characteristic 128
Shaoting Tang, Xin Jiang, Zhanli Zhang, Lili Ma, Zhiming Zheng

Authors Index 134

ISBN: 978-960-474-263-9

Plenary Lecture 1

Investigation and Numerical Solution of System of Nonlinear Integro-Differential Equations Associated with the Penetration of a Magnetic Field in a Substance

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Abstract:

It is doubtless that study of qualitative and structural properties of the solutions of initial-boundary problems for integro-differential systems are very important.

One type of integro-differential systems arise for mathematical modeling of the process of penetrating of magnetic field in the substance. In a quasistationary case the corresponding system of Maxwell's equations has the form:

$$\frac{\partial H}{\partial t} = -rot(\nu_m rot H), \quad \text{or} \quad c_\nu \frac{\partial \theta}{\partial t} = \nu_m (rot H)^2, \tag{1}$$

where $H = (H_1, H_2, H_3)$ is a vector of the magnetic field, θ is temperature, c_ν and ν_m characterize the thermal heat capacity and electroconductivity of the substance.

If c_ν and ν_m depend on temperature θ, i.e., $c_\nu = c_\nu(\theta)$, $\nu_m = \nu_m(\theta)$, then the system (1), as it was done in the work (1983) by D.Gordeziani, T.Dzhangveladze and T.Korshia, can be rewritten in the following form

$$\frac{\partial H}{\partial t} = -rot \left[a \left(\int_0^t |rot H|^2 \, d\tau \right) rot H \right], \tag{2}$$

where function $a = a(S)$ is defined for $S \in [0, \infty)$.

By assuming the temperature of the considered body to be constant throughout the material, i.e., depending on time, but independent of the space coordinates, G. Laptev (1990) proposed some generalization of the system of type (2).

There are many famous authors who investigate (2) type models.

If the magnetic field has the form $H = (0, U, V)$ and $U = U(x,t)$, $V = V(x,t)$, from the system (2) we obtain the following system of nonlinear integro-differential equations:

$$\frac{\partial U}{\partial t} = \frac{\partial}{\partial x} \left[a(S) \frac{\partial U}{\partial x} \right], \quad \frac{\partial V}{\partial t} = \frac{\partial}{\partial x} \left[a(S) \frac{\partial V}{\partial x} \right], \tag{3}$$

where

$$S(x,t) = \int_0^t \left[\left(\frac{\partial U}{\partial x} \right)^2 + \left(\frac{\partial V}{\partial x} \right)^2 \right] d\tau, \tag{4}$$

or

$$S(t) = \int_0^t \int_0^1 \left[\left(\frac{\partial U}{\partial x} \right)^2 + \left(\frac{\partial V}{\partial x} \right)^2 \right] dx d\tau. \tag{5}$$

Function $S = S(t)$ in (3) is given as in the work by G.Laptev.

We consider asymptotic behavior as $t \to \infty$ of solutions of systems of type (3),(4) and (3),(5) as well as numerical solution of these systems. We compare theoretical results to numerical ones.

Brief Biography of the Speaker:
Education
1998: Doctor of Physical and Mathematical Sciences
Ivane Javakhishvili Tbilisi State University
Thesis: "Mathematical Modeling, Investigation and Numerical Solution of Some Nonlinear Diffusion Problems"
1984: Candidate of Physical and Mathematical Sciences
(Ph.D. in Computational Mathematics)
Nikoloz Muskhelishvili Institute in Computational Mathematics of Georgian Academy of Sciences
Thesis: "Investigation and Numerical Solution of Some Nonlinear Integro-differential Parabolic Problems"
1977: Graduated from Ivane Javakhishvili Tbilisi State University for Applied Mathematics and Cybernetics, Honors Diploma in Mathematics
Field of Research
Main activities: Differential and Integro-Differential Equations. Mathematical Modeling. Numerical Analysis
Employment
2009-present: Professor (Visiting Lecturer), Ivane Javakhishvili Tbilisi State University
2010-present: Professor, Caucasus University (Tbilisi, Georgia)
2006-2010: Professor, Ilia Chavchavadze State University, Department of Physics and Mathematics
1998-2009: Professor, Ivane Javakhishvili Tbilisi State University, Department of Exact and Natural Science
1998-present: Leading Research Fellow of the Department of Partial Differential Equations (part-time position), Ilia Vekua Institute of Applied Mathematics
2001-2010: Professor (Visiting Lecturer), Caucasus University (Caucasus School of Business, Tbilisi, Georgia)
1998-2005: Professor (part-time position), Sukhumi Branch of Ivane Javakhishvili Tbilisi State University
1988-1998: Docent, Department of Applied Mathematics and Informatics, Ivane Javakhishvili Tbilisi State University
1988-1998: Senior Research Fellow of the Department of Partial Differential Equations (part-time position), Ilia Vekua Institute of Applied Mathematics
1984-1988: Invited Docent, Ivane Javakhishvili Tbilisi State University
1981-1984: Invited Assistant, Ivane Javakhishvili Tbilisi State University
1983-1988: Research Fellow, Ilia Vekua Institute of Applied Mathematics
1980-1983: Post-graduate study in Ivane Javakhishvili Tbilisi State University (Scientific Advisor: Academician, Professor Andria Bitsadze)
1977-1983: Junior Research Fellow, Ilia Vekua Institute of Applied Mathematics

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Plenary Lecture 2

On some finite difference methods for systems of multidimensional equations of parabolic type with partial derivatives

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Abstract: The lot of problems of science and the techniques, studied by means of mathematical modeling and computing experiment, is reduced to the solution of systems of the multidimensional equations of parabolic type with partial derivatives. Such problems concern: distribution of heat to the continuum, processes of transfer of substances, diffusion and many fundamental problems of natural sciences, ecology and etc.
The problem with first sort boundary conditions for systems of equations of parabolic type, containing the mixed derivatives will be considered. The two-layer and three-layer factorized schemes are constructed. The received algorithms can be effectively used for multiprocessor computing systems.
For considered difference schemes aprioristic estimations in norm of net space on a layer are obtained, on which basis the convergence of solution of the difference schemes to the solution of initial problem is proved.

Brief Biography of the Speaker: Prof. Hamlet Meladze has the scientific degree of D.Sc. in Mathematical Modeling and Numerical Mathematics (The Institute of Mathematical Modeling of Academy of Sciences of Russia). Field of his scientific interests: the numerical methods for solving of linear and nonlinear differential equations with partial derivatives; mathematical and computer modeling, parallel algorithms, fuzzy mathematics and etc.
He is head of department of informatics in Institute of Computational Mathematics (www.acnet.ge/icm) and the head of direction of Computer sciences in St. Andrew the First Called Georgian University (www.sangu.ge). Throughout many years H.Meladze works as Professor, the Head of Department of Computer Software and Information Technologies (1978-2006) and the Dean of faculty of applied mathematics and computer sciences (1993-1999) in Iv.Javakhishvili Tbilisi State University. He has the scientific award of Tbilisi state University for the best manual, also different scientific and governmental awards, medals and diplomas.
Prof. H.Meladze has about 126 scientific papers, is author of 11 books in numerical methods and informatics, editor of several books.
Prof. H.Meladze was head of project from Georgian side in various international grants.
He is Editor-in-Chief of electronics scientific journal “Computer sciences and telecommunications” (http://gesj.internet-academy.org.ge/en/title_en.php?b_sec=&section_l=comp), associate editor of journal “Applied Mathematics, Informatics and Mechanics” (http://www.viam.science.tsu.ge/Ami/Main.htm), the member of editorial board of journal “Transactions Automated Control Systems” (Georgian Technical University), also the member of editorial board of several international scientific journals.
Prof. H. Meladze was the member of international program committee and the participant of many international scientific conferences.
Prof. Hamlet Meladze is the member of European Academy of Sciences, vice-president of Academy of Natural Sciences of Georgia, the member of Academy of Educational Sciences of Georgia.

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Plenary Lecture 3

On Mathematical Models and Numerical Algorithms for Solution of Some Problems of Water Pollution

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Abstract: The mankind, having improved in various fields of science and technology and having liberalized, using environment resources and more deeply interfering in the outer world, destroys the existing balance of the earth ecosystem. Research of the ways of its prevention and rehabilitation is one of the most important tasks of contemporary world. Via computer simulation mathematical modelling and application of numerical analysis make possible to forecast these or those parameters of water quality, to control and manage pollution processes. That kind of observation and prediction are cost-effective and preserve expenses that would be needed for arrangement and conduction of experiments; sometimes such approach appears to be the only way of studying relevant phenomena. Thus, mathematical modelling of diffusion processes in the environment and investigation of pollution problems is one of the most actual and interesting challenge of applied and computational mathematics. Therefore, mathematical modelling and models themselves are being constantly improved, refined and in some cases even simplified. Actually, a big variety of non-linear mathematical models describing pollution processes exist, but in the current work we only focus on linear mathematical models describing pollution transfer and diffusion in water bodies. The literature concerning the research of problems and mathematical modelling issues on the basis of classical equations of mathematical physics with classical initial-boundary conditions is quite rich. In some works concerning mathematical modelling of admixture diffusion processes in various environments, the authors have encountered with the specific type of equations that until recently were not used to describe the above mentioned processes. Such equations are known under the name of “pluri-parabolic” equations. Theoretical issues and algorithms of numerical solution of these types of equations with classical initial-boundary conditions are poorly studied, though investigation of the mentioned problems has substantial theoretical and practical value. Here should be emphasized that in some cases during the process of mathematical modelling of pollution problems we deal with initial-boundary value problems with non-classical boundary conditions as well. Quite often the questions of investigation of mathematical problems describing pollution dissemination processes get down to classical equations of mathematical physics with non-classical (e.g. non-local) initial-boundary conditions. Finally, we would like to present mathematical models with non-classical equations and non-classical boundary conditions (conditions of Cannon, Bitsadze-Samarskii, their generalization and others). In the present work some mathematical models of the mentioned type are considered, problems of their numerical analysis and respective difference methods are developed and studied.

Brief Biography of the Speaker: David Gordeziani in 1961 graduated from Tbilisi State University, Department of Mathematics and Mechanics. In 1961-1964 post-graduate studentship; then he was junior research worker of A. Razmadze Institute of Mathematics, Georgian Academy of Sciences (1964-1968); Senior scientific worker at I. Vekua Institute of Applied Mathematics (1968-1969); Probationer of the Laboratory of Numerical Analysis in the Paris University; head of the department of Numerical Methods of I. Vekua Institute of Applied Mathematic; Supervised the scientific work of the department in shell theory, meteorology, ecology, magnetic hydro-dynamics, computation and optimization of gas pipelines, took part in special scientific works(1969-1979); Deputy Director of I. Vekua Institute of Applied Mathematics (1979-1985) where he supervised the Institute scientific-research works; in 1985-2006 director of I. Vekua Institute of Applied Mathematics; head of Department of Computational mathematics of Tbilisi State University; supervised the Institute scientific-research works concerning investigation and realization of different problems of mathematical physics and mechanics of continuum media, problems of the theory of elastic mixtures, nonlocal-in-time problems for some equations of mathematical physics, mathematical models for computation of thermo-elastic state of some energetic plants; full professor of Tbilisi State University (2006-2009); from September 2009 Emeritus at the Iv. Javakhishvili Tbilisi State University. Since 1963 till now read the lectures in programming and computational mathematics, mathematical modeling, functional analysis and computational mathematics,

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numerical methods of partial differential equations etc. at the Tbilisi State University. In 1966 defended Ph.D. thesis in specialty "Computational mathematics". In 1981 defended a thesis for a Doctor of Science (habilitation) degree in specialty "Computational mathematics" at the Moscow State University. Supervised preparation and defenses of 17 Candidate thesis and 7 thesis for a Doctor of Science degree (habilitation). He participated in organization and holding of many international, republic congresses, symposiums, conferences, schools on mathematics, computational mathematics, mechanics, theory of shells, hydro-dynamics, magnetic hydrodynamics, informatics (International Congresses of Mathematics, Athens Interdisciplinary Olimpia, IUTAM Symposium, etc.). Was invited to carry lecture courses and scientific researches, participation in congresses, conferences and symposiums in scientific centers of many countries. Hi is the author of more than 170 scientific publications, 4 inventions (USSR), 2 patents (USA, Sweden) and 3 Monographs; the member of the Engineering Academy of Georgia; the member of the International Academy of Computer Sciences and Systems; the honorary president of Georgian Academy of Natural Sciences, etc.; the member of editorial board of mathematical journals, supervisor and team member in various international grants and owner of different scientific and governmental awards, prizes, medals and diplomas.

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Plenary Lecture 4

Statistical Inference for Shannon and Renyi Information

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Abstract: We present a class of estimators for the Shannon and Renyi information of multi-dimensional probability density, based on the k-th nearest distances in a sample of i.i.d. vectors (see Leonenko, Pronzato and Savani (2008)). The method can be extended to the estimation of the statistical distances between two distributions using one i.i.d. sample from each. An applications of different entropies (a-entropy and quadratic Renyi entropy, see Leonenko and Seleznev (2009)) are also studied. The other approaches to estimation of entropy are discussed.
This is a joint results with Luc Pronzato (University of Nice-Sophia), and Oleg Seleznev (Umea University, Sweden).

Brief Biography of the Speaker: Nikolai Leonenko MD PhD is a Professor of Statistics at Cardiff School of Mathematics, Cardiff University, Wales, UK. His areas of expertise are: statistical estimation of Shannon and Renyi information and statistical distances; statistical analysis of stochastic processes and random fields; spectral theory of random fields; statistical inference with higher-order information; fractional differential equations and PDE with random data; multifractal processes and fields; finance and stochastic; first passage distribution problem of Pearson jump-diffusion. Besides being an author and co-author of 180 papers, he wrote 2 books. He was awarded by N. M. Krylov medal of Academy of Science of Ukraine (1993), the highest annual award for mathematicians in Ukraine, and he is a Member of the American Mathematical Society, London Mathematical Society and Kyiv Mathematical Society.

ISBN: 978-960-474-263-9

Authors Index

Belingher, C. B. 67
Dasta, M. 61
Dima, I. C. 109
Eskandari, H. 17
Farzad, V. 61
Gallitano, G. M. 49
Goldbach, I. R. 109
Grabara, J. 109
Jackson, K. 49
Jangveladze, T. 79, 105, 116
Jiang, X. 128
Jula, D. 67
Jvadi, Sh. 61
Kadivar, P. 61
Karam, J. 101
Kiguradze, Z. 55, 116
Kolyshkin, A. 44
Lobjanidze, G. 116
Ma, L. 128
Man, M. 109
Mehdizadeh, E. 27
Mousavi, S. M. 27
Nadjafi, B. A. 20
Nan, M. S. 67
Necula, S.-C. 85, 91
Nicolescu, C. 67
Nikolishvili, M. 105
Pei, S. 122
Petre, G. 67
Radu, D.-L. 91
Rahimi, A. 20
Ranjbar, A. 33
Tabatadze, B. 105
Tang, S. 128
Tavarroth, M. R. 27
Vaillancourt, R. 44
Varlan, S.-E. 97
Voicu, G. V. 67
Voskoglou, M. G. 73
Zhang, Z. 128
Zheng, Z. 122, 128

ISBN: 978-960-474-263-9