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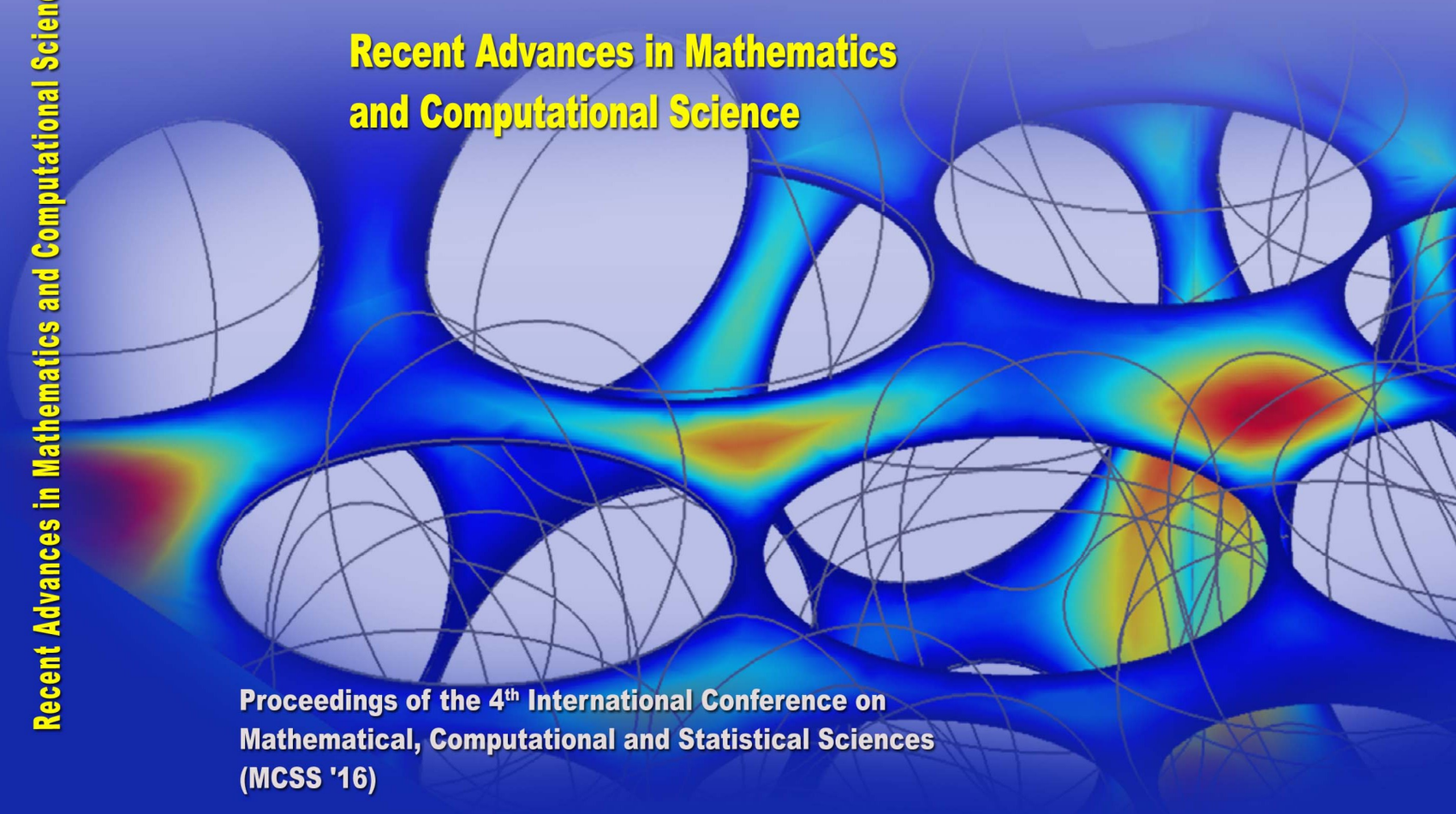
Recent Advances in Mathematics and Computational Science



Proceedings of the 4th International Conference on Mathematical, Computational and Statistical Sciences (MCSS '16)

Barcelona, Spain, February 13-15, 2016

Mathematics and Computers in Science and Engineering Series | 58

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Plenary Lecture 1

Non-Stationary Response of a Beam for a New Rheological Model

Professor Olga Martin
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Abstract: In the last twenty years, the fractional derivative is used in many fields, such as rheology, control systems, heat transfer, fluid mechanics, electro-chemistry. In contrast to integer order derivative that depends on the local conditions of the function, the fractional derivative depends on the time history of the function and because of this, it is used to study the hereditary processes.
For beginning, the paper is intended to provide the quasi-static and classical dynamic analysis of beam for a viscoelastic material model. Then, the results were extended to a fractional Zener model that has been studied using the techniques of Laplace transform and binomial series. An example proves the accuracy of the solution for a simply-supported beam subjected to a uniform distributed load. Theoretical and numerical solutions can be easily used to calculate the complex structures configurations.

Brief Biography of the Speaker: Olga Martin graduated the Faculty of Mathematics and Mechanics, University of Bucharest, Romania. She received his PhD in mathematics with the specialization in Dynamic Plasticity with paper work 'Applications of the Finite Element Method in Dynamic Plasticity'. During of twenty years, she had been senior researcher in Aircraft Institute, Strength Materials Department. Technical experience: structural strength computing reports using ANSYS program (wing-fuselage, fuselage frame, fin, elevator, rudder and aileron), dynamic and static test-programs for aircraft structures, fatigue test-programs for aircraft structures, iterative methods for the study of the reactions, which correspond to movable control surfaces, attached at n – points to an elastic structure and program of this, static and fatigue computation of the propeller (mono-bloc hub, blades and blades retention system). Nowadays, she is Professor at Applied Sciences Faculty, University "Politehnica" of Bucharest.
Fields of specialization: Mathematical Analysis, Mathematical Physics, Computational and Experimental Solid Mechanics, Plasticity Dynamics, Structural Strength Calculus, Numerical Analysis, Statistical Calculus. She has published over 98 research papers and 18 books. Member of the editorial boards: Politehnica Sci. Bull. Series A, WSEAS Transactions on Applied and Theoretical Mechanics and she was involved in the program/organizing committees for many international conferences. Membership of Professional Societies: Society of Computer Aided Engineering – Member National Union of Romanian Scientists (Founding member), Balkan Society of Geometers member, Romanian Society of Mathematicians. Reviewer: WSEAS Press (books and journals), Scientific Bulletin, University "Politehnica" of Bucharest, Acta Mathematica Universitatis Comenianae, Journal of Quantitative Spectroscopy and Radiative Transfer. Scientific Evaluation Societies: RELANSIN, University "Politehnica" of Bucharest, ARACIS, Bucharest, Bucharest, National Science Fund of Bulgaria, Executive Unit for Research Development and Innovation of Romania.

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Plenary Lecture 2

Mathematical Modelling of Deterministic and Random Composites

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Abstract: The talk is devoted deterministic and random heterogeneous materials and to constructive analytical methods to compute their macroscopic properties. Randomness in such problems reveals through random tensor-functions locally describing the physical properties of medium. Despite the considerable progress made in the theory of disordered media, the main tool for studying such systems remains numerical simulations. Frequently, it is just asserted that it is impossible to get general analytical formulae for the effective properties except dilute composites when interactions among inclusions are neglected and except regular composites having simple geometric structures. This opinion sustained by unlimited belief in numerical computations have to be questioned by the recent pure mathematical investigations devoted to explicit solution to the Riemann-Hilbert problem for multiply connected domains and by significant progress in symbolic computations. These recent theoretical results can be effectively implemented in symbolic form that yields analytical formulae for random composites. In this talk, we restrict ourselves to two-phase conducting composites with non-overlapping inclusions. The proposed method leads to construction of the new RVE (representative volume element) theory for dispersed composites. The effective tensor can be written in the form of expansion in the moments of the correlation functions which can be considered as "basic elements" depending only on locations of inclusions. The RVE is defined as the minimal size periodicity cell corresponding to the set of basic elements calculated for the composite. A simple fast algorithm to determine the representative cell for a given composite is based on reduction of the number of inclusions per periodicity cell having the same basic elements as the given composite. The results are applied to random optimal packing and to computation of the corresponding critical exponent for superconducting inclusions. A criterion of stir casting processes is introduced. It is explained why the hexagonal pattern formation is frequently met in nature.

Brief Biography of the Speaker: Vladimir Mityushev graduated the Faculty of Mechanics and Mathematics at the Byelorussian State University of Minsk (Belarus) in 1980 and obtained PhD in Physics and Mathematics in 1984 at the same University. He has obtained the habilitation degree in Technology at Poznan Technological University (Poland) in 1997. His research fields includes: Mathematical modeling and computer simulations, Industrial mathematics, Boundary value problems, Riemann-Hilbert problem for multiply connected domains, Iterative functional equations, Elliptic PDE, Effective properties of composites with deterministic and random structure, Fiber composites, RVE, Porous media, Permeability and diffusion, Navier-Stokes equations in domains with complex geometry, Viscous flow in wavy channels, Elasticity, Thermoelasticity and Mechanics of fracture, Electroosmotic phenomena, Symbolic computations, Packing, Deterministic and random graphs. He published as author or co-author over 150 articles in journals. Vladimir Mityushev wrote and edited 11 books. He is Visiting research professor of Equipe Milieux Poreux et Fracturés Paris VI, France. He is a member of AMS and of ISAAC, Academician of Russian Academy of Informatization.

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Plenary Lecture 3

Non-Linear Dynamics of Interacting Structural Members

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Abstract: We develop mathematical models of interacting structural members (beams and plates) subject to regular and noisy loads. The governing partial differential equations are reduced to a truncated system of ordinary differential equations. Spatial-temporal chaotic vibrations of a plate and two/three beams coupled only by boundary conditions are studied. Novel transition scenarios from regular to chaotic dynamics of the mentioned deterministic systems are detected, illustrated and discussed. The modifications of classical three scenarios of transition from regular vibrations to deterministic spatial-temporal chaos are proposed and validated. It is shown, among other, how the white noise lowers the threshold for transition into spatial-temporal chaotic dynamics and how it significantly reduces occurrence of periodic vibrations. It is reported that a scenario of transition into chaos of the studied mechanical interacting slender structures essentially depends on the control parameters, and it can be different in different zones of the constructed charts of vibration kinds (control parameter planes). Furthermore, two interesting non-linear phenomena are illustrated and discussed. The first one is associated with increase of the noise intensity, which yields surprisingly the vibrational characteristics with a lack of noisy effect (chaos is destroyed by noise and windows of periodicity appear). The second one deals with a loss of symmetry of the previously symmetric dynamical regime yielded by action of a small symmetrically distributed white noise.

Brief Biography of the Speaker: Graduated from the Lodz University of Technology (TUL) in 1977 (Mechanics) and from the University of Łódź in 1978 (Philosophy), Poland. He became a Full Professor in 1997. Now, he is the chairperson of Department of Automation, Biomechanics and Mechatronics, the head of the 4-year Ph.D. Course on Mechanics, and the head of the Mechatronics Course at TUL. His research includes: Nonlinear Mechanics (analytical, numerical and experimental methods; structural and lumped mass mechanical systems; thermo-elasticity; asymptotic methods; dynamics; bifurcation and chaos; numerical methods; non-smooth and discontinuous systems), Mechatronics and Control (vibrations control; optimization), Biomechanics (modeling of human organs; stability of human gait; experimental and numerical methods). He has served on Editorial Boards of 65 journals, gave 73 seminars at international universities, delivered 55 plenary/keynote talks, attended 310 conferences, and served as a member of scientific committees of over 170 conferences. He spent 10 years abroad carrying out research supported by Fulbright Award for Seniors, University of California, Berkeley, 2001; T. Kosciuszko Foundation Award, University of Illinois, USA, 1999/2000; Research Centre for Advanced Science and Technology, Tokyo University, Japan, 1992; Japan Society for Promotion of Science and Technology, Tokyo University, 1990/1991; Alexander von Humboldt Foundation, University of Braunschweig, Germany, 1987-1990, 1993; 'TEMPRA' Program, 1995, Région Rhône-Alpes (ENTPE), Valeaux-en-Velin/Lyon; NATO Grant Award, Lyon, 2005; Central European University (Budapest) 2003/2004; Waikato University, Hamilton (New Zealand) 1996/1997. He was a principal investigator of 15 grants of the Committee for Scientific Research (KBN) in Poland, two TEMPRA grants (1995/1996; 2000/2001) and POLONIUM grant (1999/2001). He is a recipient of: Honorary Doctor Awards of the Bielsko-Biała Academy of Arts and Technology and the Częstochowa University of Technology; MAESTRO grant (2012-2016), Poland; Humboldt Research Award for Seniors, Germany, 2011-2012; MASTER Grant Award, Foundation for Polish Science, 2010-2012; GOLDEN LAMP Award (PGNiG) in technical sciences, 2006, Poland.

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Plenary Lecture 4

Efficient Heuristics for Discrete Optimization Problems

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Abstract: Combinatorial optimization (CO) problems constitute a significant class of practical problems with a discrete nature. They have emerged in late 40-s of 20th century. With a rapid grow of the industry, the new demands in the optimal solution of the newly emerged resource management and distribution problems have arisen. For the development of effective solution methods, these problems were formalized and addressed mathematically. The CO problems are partitioned into two basic types, type P, which are polynomially solvable ones, and intractable NP-hard problems. Tt is believed that it's very unlikely that an NP-hard problem can be solved in polynomial time. Hence, fast approximation algorithms are of a great demand. Greedy (heuristic) algorithms are efficient polynomial-time algorithms that create a feasible schedule. In this talk we shall discuss about the importance of heuristic solution methods for NP-hard optimization problems. Although all heuristic methods are fast, the quality of the solution that they deliver may vary a lot. Hence, heuristic algorithms with a good performance guarantee are of a primary interest. The scheduling problems constitute an important class of the discrete optimization problems. They deal with a finite set of requests called jobs to be performed (or scheduled) on a finite (and limited) set of resources called machines (or processors). The aim is to choose the order of processing the jobs on machines so as to meet a given objective criteria. A basic 2-approximation heuristic was suggested by Jackson in early 50s last century for scheduling jobs with release times and due-dates to minimize the maximum job lateness. The theoretical worst-case bound of 2 helps a little in practice, when the solution quality is important. The quality of the solution delivered by Jackson's heuristic is closely related with the maximum job processing time pmax that occurs in a given problem instance and with the resultant interference with other jobs that such a long job may cause. We will show how the relationship of pmax with the optimal objective value can be used to obtain more accurate approximation ratio. As it was demonstrated in practice, by the computational experiments, the derived estimation may drastically outperform the worst-case ratio of 2.

Brief Biography of the Speaker: Nodari Vakhania is a titular professor at the Science Faculty, the State University of Morelos, Mexico and at the Institute of Computational Mathematics of the Georgian Academy of Sciences. He has received his Ph.D. degree in mathematical cybernetics at the Russian Academy of Sciences in 1991, and the doctoral degree (habilitation) in mathematical cybernetics at the Georgian Academy of Sciences in 2004. His main research interests include design and analysis of algorithms, discrete optimization, computational complexity and scheduling theory. He is an author of over 60 refereed research papers. His articles were published in Journal of Algorithms, Journal of Scheduling, Journal of Computer and System Sciences, Annals of Operations Research, Operations Research Letters, Naval Research Logistics, Theoretical Computer Science, International Journal of Production Research and other high-ranked international journals. Professor Vakhania has been worked in different scientific committees including those at Mexican Science Foundation CONACyT. He is an editor of Advances in Pure Math., Int. J. of Advanced Math. Sciences, Scientific World Journal, and a referee of Journal of Algorithms, Journal of Scheduling, Information Processing Letters, OMEGA, Computers & Operations Research, Operations Research Letters, Int. J. of Applied Intelligence, Mathematics of Operations Research and others. He has obtained research grants and honors in Germany, France, The Netherlands, USA, Russia and Mexico and had over 40 invited talks throughout the world.

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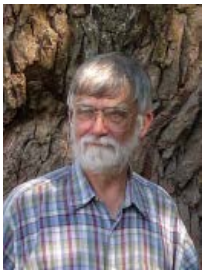
Plenary Lecture 5

Some Mathematical Problems in the Theory of Boiling Liquids



Professor Ruediger Landes
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Abstract: In a new attempt to describe certain states of boiling liquids mathematically, such as “nucleate boiling, transient boiling and pool boiling” Professor W. Marquart from Aachen proposed to consider the heat equation in the wall of the heater subject to a nonlinear Neumann boundary condition towards the boiling liquid, but without any attempt of modeling the boiling liquid itself. The results that we present indicate that this parabolic equation with the nonlinear boundary condition indeed has solutions with properties observed experimentally. Such as the existence of traveling wave solutions which model the phase ransition from nucleate boiling to transient boiling. We also construct weak supersolutions which provide bounds for the propagation speed of such an phase transitions. Further, we are able to construct stable supersolutions to initial configurations with locally supercritical values, indicating that at least for a short time both states may exists together, as it has been observed experimentally. To study this phenomenon further, Speetjens et. al. have conjectured that the solution gives rise to a semigroup with an attractor being the unstable manifold of its fixed point set. We verify that the solution has indeed that property. But we point out that the semigroup should be considered acting on L2 and not on H1 as suggested in their conjecture.

Brief Biography of the Speaker: Rüdiger Landes studied mathematics at University of Munich and the University of Göttingen and received his Diploma from the University of Göttingen. He graduated with an PhD from the University of Bochum and then worked for one Year at the SFB 272 in Bonn. In 1984 he promoted with a Habilitation at the University of Bayreuth. Thereafter he spend a year on visiting appointment at the University of Chicago and then joined the faculty at the University of Oklahoma. His research is devoted to nonlinear problems in partial differential equations. The main areas of his work are: The existence of solution elliptic and parabolic equations and systems with perturbations of unlimited growth, the existence, uniqueness and regularity of quasilinear elliptic systems with critical growth, and the dynamical behavior of solutions of parabolic problems with nonlinear boundary conditions. He was on research sojourns at the University of Oulu, Finland, at the University of Catania, in Italy, with SFBs at University Bonn and at the University Heidelberg, Germany twice, at the MSRI, Berkely, USA, and at University Dresden in Germany. He is member of the editorial board of Applied and Abstract Analysis and the International Journal of Pure Mathematics.

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Plenary Lecture 6

Parametric and Nonparametric Approaches to Evaluate the Agreement of Medical Measurements

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Abstract: The well-known limits of agreement are usually used to evaluate the agreement between two alternative medical measurements methods, when the distribution of their differences is normal. In this case study the empirical distribution of the differences of serum levels of vitamin B12 in a blood sample does not verify the assumption of this parametric approach, since it is positive skewed, leptokurtic and has some outliers. Thus, the limits of agreement are also estimated after a Box Cox transformation, for an appropriate regression and for a nonparametric approach. A bootstrap resampling method is also used in order to obtain robust confidence intervals, for the mean and median of differences (which estimate the bias). The statistical results seem to emphasize the interchangeability of both methods, although some lack of agreement. Medical researchers may use these simple and attractive approaches, namely using a spreadsheet program, which outputs (easily interpreted) might be useful in clinical judgment to decide whether agreement is acceptable or not.

Brief Biography of the Speaker: Luis Miguel Grilo (PhD in Mathematics and Statistics, Technical University of Lisbon, 2006) is currently Adjunct Professor and Director of the Department of Mathematics and Physics, as well as Director of Surveys and Statistical Studies Center of the Polytechnic Institute of Tomar (PIT) and of a Post Graduation in Computational Data Analysis. As a member of the Center for Mathematics and Applications of the New University of Lisbon (CMA UNL), develops scientific research in Distributions Theory (exact and near-exact distributions of some statistics used in Multivariate Analysis) and Statistics Applications (with special interest in Health). Publishes papers regularly in international scientific journals and has made several presentations at national and international meetings of Statistics, including as an Invited Speaker, receiving the "Best presentation award", in the PhD student category, with a paper presented at the International Conference on Statistics, Combinatorics and Related Areas and X Conference of the Forum for Interdisciplinary Mathematics (SCRA2003|FIMX), University of Southern Maine, USA. At the moment, is Academic editor of the British Journal of Mathematics & Computer Science, member of the Editorial Board of the Asian Journal of Mathematics and Computer Research and member of the board of CLAD (Portuguese Association of Classification and Data Analysis). As a member of Scientific and Organizing Committees, has participated in several national and international meetings of Statistics. In particular, in the PIT was the Chair of the International Conferences SCRA2006|FIM XIII, the XIX Conference on Classification and Data Analysis (JOCLAD2012), the 7th Workshop on Statistics, Mathematics and Computation (WSMC7, 2013) and the 5th International Conference on Risk Analysis (ICRA5, 2013).

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