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Mathematical and Computational Methods in Applied Sciences

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- *Proceedings of the 3rd International Conference on Applied, Numerical and Computational Mathematics (ICANCM '15)*
- *Proceedings of the 5th European Conference of Chemical Engineering (ECCE '15)*
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Table of Contents

Plenary Lecture 1

Conservative Averaging Method: Applications and Theory

Professor Andris Buikis
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Abstract: The idea of conservative averaging method is at least 100 years old; the origins can be found in papers of Knezer A., Samarskii A. and Tikhonov A. This idea was employed in the modeling of heat transfer processes and improvement of oil recovering process. Practically in all papers non-classical boundary conditions will be obtained in the intuitive form by obtaining some specific peculiarities of concrete task, without well-founded mathematical basis. The mathematical basis was given in thesis of doctor of sciences Buikis A. In the thesis the method was named "conservative averaging method." In this publication of 1980ies and other papers was used the function approximation with polynomial, including polynomial and rational splines. Later exponential approximation for electric wires and car fuses was developed. Now, together with colleagues Professor Kalis H. and others we use new hyperbolic approximation with numeral parameters. In the lecture are given numerical calculations for ordinary and partial differential equations as samples of several mathematical models.

Brief Biography of the Speaker: Andris Buikis received the M.S. in numerical mathematics from University of Latvia (Faculty of Physics and Mathematics) in 1963 and Dr. math. (Candidate of Science in former USSR), University of Latvia, in 1970. He was Junior Researcher, Senior Researcher, Computing Centre, University of Latvia, 1962 – 1972. Assistant Professor and Head of Chair of Applied Mathematics, 1972 – 1976 and Head of Chair of Differential Equations and Numerical Methods, Faculty of Physics and Mathematics, University of Latvia, 1976 – 1984. Dr. habil. math. (Doctor of Science in former USSR), University of Kasan, Russia, 1988. Professor, University of Latvia, 1991. Director, Institute of Mathematics, Latvian Academy of Sciences and Latvian University, 1991 - 1996; 2003 – 2006 and Director, Science and Dialogue Centre of Latvia, 1993 -2007. Head of Laboratory of Mathematical Technologies, Institute of Mathematics and Computer Science, University of Latvia 2006-2010.
From 2010 he was thrice elected as Member of Saeima (Latvian Parliament), now till year 2018. Full Member, Latvian Academy of Sciences, 1997. Member, Senate of the Latvian Academy of Sciences, 1994 –2012. The Latvian Academy of Sciences Piers Bohl Prize for a cycle of papers "Method of Conservative Averaging, Theory and Applications", 2005. Member of Editorial Advisory Board, Journal Mathematical Modelling and Analysis (The Baltic Journal on Mathematical Applications, Numerical Analysis and Differential Equations), Lithuania 1999- Associate Editor of WSEAS Transactions in Heat and Mass Transfer 2007-, Associate Editor of Journal of Vortex Science and Technology 2012- and Academic Editor of Current Research International 2014-.

Plenary Lecture 2

On Some Functional Equations Arising in the Communication Networks

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Abstract:

Numerous researchers have investigated various examples of functional equations that are of the general form

$$C_1(x,y)P(x,y) = C_2(x,y)P(x,0) + C_3(x,y)P(0,y) + C_4(x,y)P(0,0), \tag{1}$$

where C_i, $i = 1,2,3,4$, are given functions in two complex variables x, y and the unknown function P is a probability generating function (PGF). So, P is defined and analytic in the closed unit disc of the complex plane. The equations have many important applications in the queuing theory and in the communication networks (see, e.g., [1, 2, 6, 7, 9, 12, 13, 14]).

A quite popular technique of solving those equations is a reduction to a boundary value problem (cf. [3, 4, 5, 8]). Unfortunately, that approach is not always sufficiently effective and there is no universal efficient solving method known for such equations, so far.

The lecture contains some general remarks concerning the issue of solving the equations, with some examples. In particular, we discuss the cases of the following two functional equations

$$y(x - A(x,y))P(x,y) = A(x,y)[(\overline{\gamma}xy + \gamma x - y)P(0,y) + \gamma x(y-1)P(0,0)], \tag{2}$$

and

$$\left[(1+\alpha+\beta)xy - \alpha y - \beta x - x^2y^2\right]P(x,y) = \beta x(y-1)P(x,0) + \alpha y(x-1)P(0,y), \tag{3}$$

where the unknown function P is a PGF, and therefore must be of the form

$$P(x,y) = \sum_{m,n=0}^{\infty} p_{m,n}x^m y^n,$$

with some sequence of nonnegative real numbers $p_{m,n}$ $(m,n = 0,1,2,\ldots)$ satisfying the normalization condition

$$\sum_{m,n=0}^{\infty} p_{m,n} = 1.$$

The first equation (2) arises in [10] (see also [11]) in a performance analysis of an ATM (Asynchronous Transfer Mode) buffered switch transmitting two-class traffic over unreliable channels. The port is modeled as two logical queues with one server offering two service rates, 1 and γ, with r_1, r_2 being the arrival rates of class-1 and class-2 packets, respectively, and

$$A(x,y) = \left(1 - \frac{r_1+r_2}{N} + \frac{1}{N}(r_1x + r_2y)\right)^N,$$

where N is the number of input/output ports and $\overline{\gamma} = 1 - \gamma$.

The second equation (3) was obtained in [6], in a double queue model, where the arriving customers simultaneously place two demands handled independently by two servers, with service times rates α, β and the stability condition $1 < \alpha \leq \beta$.

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Brief Biography of the Speaker: Present permanent employment: Department of Mathematics, Pedagogical University, Kraków, Poland;
position of professor
1983 – Master of Science in Mathematics, Jagiellonian University, Kraków, Poland
1991 – PhD in Mathematics
2000 – Habilitation in Mathematics
Major research interests: functional equations and inequalities with their applications, Ulam's type stability (e.g., of difference, differential, functional, integral and operator equations), real and functional analysis, fixed point theory.
Author of over 100 papers that are already printed or accepted for publication.
Chairman of the Scientific Committee of the series of conferences: International Conference on Functional Equations and Inequalities (ICFEI) (http://uatacz.up.krakow.pl/icfei/15ICFEI/)
Chairman of the Organizing Committees of 10th (2005), 11th (2006), 12th (2008), 13th (2009), 14th (2011), 15th (2013), and 16th (2015) ICFEIs (http://uatacz.up.krakow.pl/icfei/15ICFEI/prev.php)
Chairman of the Scientific and Organizing Committees of the conference: Conference on Ulam's Type Stability, Ustron (Poland), June 2-6, 2014 (http://cuts.up.krakow.pl/)
Member of the Programm or Scientific Committees of several other international conferences
Editor (jointly with Th.M. Rassias) of the monograph Functional Equations in Mathematical Analysis (nearly 750 pages; collection of 47 papers of 67 authors), volume 52 (2013) of Springer Optimization and Its Applications series, dedicated to the 100th anniversary of S.M. Ulam
Lead Editor of Banach Center Publications volume 99 (2013) titled: Recent Developments in Functional Equations and Inequalities. Selected Topics
Lead Guest Editor of Abstract and Applied Analysis annual special issues: Ulam's Type Stability (http://www.hindawi.com/journals/aaa/type.stability/) in the years 2012, 2013
Lead Guest Editor of Journal of Function Spaces (formerly: Journal of Function Spaces and Applications) special issue: Ulam's Type Stability and Fixed Points Methods (http://www.hindawi.com/journals/jfs/si/329604/cfp/)
Lead Guest Editor of Discrete Dynamics in Nature and Society special issue: Approximate and Iterative Methods (http://www.hindawi.com/journals/ddns/si/473241/)
Supervisor of four promoted PhD students.
Editor of several international journals.
Plenary speaker of several international conferences.