Editor

Dana Anderson

Recent Advances in Applied & Theoretical Mathematics

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Preface

This year the 18th WSEAS International Conference on Applied Mathematics (AMATH '13) and the 1st WSEAS International Conference on Discrete Mathematics, Combinatorics and Graph Theory (DIMACOG '13) were held in Budapest, Hungary, December 10-12, 2013. The conferences provided a platform to discuss linear algebra, numerical analysis, differential equations, probabilities, statistics, operational research, optimization, algorithms, discrete mathematics, coding theory and cryptology, information theory, combinatorics, graph theory, game theory, hybrid discrete and continuous mathematics etc with participants from all over the world, both from academia and from industry.

Their 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 these conferences are published in this Book that will be sent to international indexes. They will be also available in the E-Library of the WSEAS. Extended versions of the best papers will be promoted to many Journals for further evaluation.

Conferences such as these 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

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Plenary Lecture 1

Numerical Solution to Maxwell's Equations by a Subdomain Method

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Abstract: We propose a new numerical method to solve the Maxwell equations in singular domains, as for example non convex polygonal domains. We focus on the computation of the static magnetic field, and show that the key point to solve this problem is related to the solution of a Laplace-like operator in a singular domain. We then introduce a new subdomain approach, that consists in decomposing the domain into 2 subdomains, and to derive an ad hoc variational formulation, in which the interface conditions are imposed with a method deduced from a Nitsche approach. Numerical examples to illustrate our method will be shown.

Brief Biography of the Speaker: Pr. Franck Assous received a Ph.D. degree in Applied Mathematics from the University of Paris (France). He then received the French "Habilitation a Diriger les Recherches" degree from the University of Toulouse (France). He worked more than 14 years at the Atomic French Agency (CEA) as a senior researcher. In parallel, he was teaching at the ENSTA School of Engineers (Paris) as an Assitant Professor, then at the Versailles University as an Associate Professor. He is currently working in Israel, where he is Professor of Applied Mathematics at the Ariel University Center (Israel), and at the Bar-Ilan University (Israel). His research project include numerical methods for Partial Differential Equations, with a particular interest for problems arising from models in the field of computational electromagnetism, plasma physics, elasticity. He is also interested in inverse problem in wave propagation problems.

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Plenary Lecture 2

Use of Orthogonal Arrays and Design of Experiments via Taguchi Methods in Software Testing

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Abstract: Software development project employs some Quality Control (QC) process to detect and remove defects. The final quality of the delivered software depends on the effort spent on all the QC stages. Given a quality goal, different combinations of efforts for the different QC stages may lead to the same goal. For the quality of the final software we use the commonly used measure of delivered defect density - the number of defects present in the final product normalized by the size of the product. One of the main objectives of a project is to achieve the desired quality goal with least amount of resources. Using defects as the defining metric for quality, we can view the process of a project as comprising of defect injection and removal stages. There are some stages like the requirements, design and coding, in which defects are injected. These defects are removed in various QC stages. A QC stage can be characterized by the defect removal rate of that stage. There can be many possible combinations of defect removal rates for the different QC stages that can achieve the same overall quality goal. The different combinations will have different implications on the total QC effort. Clearly, for a process designer or a project manager. A key problem is to select the amount of effort to be spent in each QC stage such that the desired quality goal is met with the minimum cost. We propose a model i.e. Optimal SQM for the cost of QC process and then view the resource allocation among different QC stages as an optimization problem. Software testing consumes 30-70% of the development resources; however, shipped products may still have many residual faults resulting in low reliability, high usage cost, and high maintenance cost. For software testing process optimization we apply Orthogonal Array-Based Robust Testing (OART) and Design of Experiments via Taguchi method.

To solve the problem of great number of test cases, and to force the configuration testing to be effective, combinatorial testing is proposed, using an OART Strategy as a systematic, statistical way of testing pair-wise interactions. This combinatorial approach to software testing uses models to generate a minimal number of test inputs so that selected combinations of input values are covered. The OART method can simultaneously reduce testing costs, product introduction delays, and faults going to the field by generating test cases that are more efficient and thorough in finding faults. Often the result is a 50% reduction in the number of tests and detection of more faults.

An advantage of the Taguchi method application in Software Testing is that it emphasizes a mean performance characteristic (Defect Removal Efficiency of a QC stage and cost of software Quality) value close to the target value rather than a value within certain specification limits, thus improving the product quality. Additionally, Taguchi's method for experimental design is straightforward and easy to apply to many engineering situations, making it a powerful yet simple tool. It can be used to quickly narrow down the scope of a research project or to identify problems in a manufacturing process from data already in existence. Also, the Taguchi method allows for the analysis of many different parameters without a prohibitively high amount of experimentation. For example, a process with 8 variables, each with 3 states, would require 6561 (38) experiments to test all variables. However using Taguchi's orthogonal arrays, only 18 experiments are necessary, or less than 0.3% of the original number of experiments. In this way, it allows for the identification of key parameters that have the most effect on the performance characteristic value so that further experimentation on these parameters can be performed and the parameters that have little effect can be ignored.

We give examples in this paper to show how optimal allocation of effort to each QC stage can be done to achieve a goal with minimum total effort. We also discuss how the model parameters can be obtained from process performance data that is often collected by organizations. We have also built a software that, given the project parameters, gives the optimal resource allocation schedule for any given overall quality goal.

Brief Biography of the Speaker: Ljubomir Lazic graduated from the University Electrical Engineering School, Serbia in 1979. In the 1980s he worked as Embedded Software and Hardware Test Engineer, Test Manager and Senior Researcher at Military Technical Testing Center (MTTC). He was a member of MTTC's Scientific Council, Belgrade, Former Yugoslavia and ICT Military Expert at Yugoslav Army Headquarters. Also in the 1990s, he has been working for a local telecommunications SIEMENS Company in Belgrade as Chief Engineer in Sales & Marketing Division,

Installation & Commissioning Manager and Maintenance Manager. He continued to serve industry in a variety of roles, including consulting, executive education, and expert testimony. He is docent in Computer Science at the State University of Novi Pazar, Serbia (2007- current), and docent in Software Engineering, University Union of Belgrade (2006-2010). His research interests are in Software Engineering, Software Project Management, Software Testing, Human Computer Interaction, and Component Based Engineering. Current research interests, doing as a Project leader, in two projectssupported in part by the Ministry of Science and Technological Development of the Republic of Serbia under Grant No. TR-1318 (2008-2011) and TR-35026 (2011-2014) are: Optimal software project management, Software Metrics, Effort Estimation Modeling etc. He is author of about 90 papers published in international journals and conference proceedings, invited speaker (Keynote speaker at QA&TEST 2010, 9th International Conference on Software QA and Testing on Embedded Systems, 27-28-29 October - Bilbao, Spain,2010) and book chapters.

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Plenary Lecture 3

Solution of Eddy Current Testing Problems for Media with Axisymmetric Flaws of Finite Size

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Abstract: In the present talk we consider two approaches for the solution of eddy current problems for media with axisymmetric flaws. The first approach is based on a perturbation method where a small parameter represents the difference between the electrical conductivites of a flaw and a surrounding conducting medium. Approximate change in impedance of a coil due to the flaw in the form of a circular cylinder of finite size is found in terms of a double integral containing Bessel functions. In addition, the applicability of the layer approximation to the solution of axisymmetric problems with flaws is also discussed.
The second approach uses the TREE method in order to construct semi-analytical solutions of the problem. The main idea of the TREE („Truncated Eigenfunction Expansions") method is that the vector potential is assumed to be exactly zero at a sufficiently large radial distance from the coil. The corresponding boundary value problem for the vector potential in each region of interest can be solved by the method of separation of variables. The method is not truly analytical since two aspects of the procedure require the use of numerical methods. First, a set of complex eigenvalues has to be determined numerically. Second, a system of linear algebaric equations for the expansion coefficeints has to be solved numerically as well. Different types of problems including axisymmetric flaws are considered. Results of numerical simulations are presented. Calculated results are compared with available experimental data.

Brief Biography of the Speaker: Andrei Kolyshkin received his undergraduate degree in Applied Mathematics in 1976 at the Riga Technical University. In 1981 he received a Ph.D in differential equations and mathematical physics at the University of St. Petersburg (Russia). Andrei Kolyshkin is currently a full professor at the Department of Engineering Mathematics at the Riga Technical University. His current research interests include investigation of stability problems in fluid mechanics with applications to open- channel flows, transient flows in hydraulic systems and mathematical models for eddy current testing. He is the co-author of three monographs published by Academic Press and CRM. Andrei Kolyshkin has participated in more than 40 international conferences and has published more than 70 papers in refereed journals since 1980. As a visiting professor and visiting researcher he spent a few years at the University of Ottawa and Hong Kong University of Science and Technology.

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Plenary Lecture 4

Tensional Psychological Dynamics between Determinism and Predeterminism

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Abstract: Tensional psychological construct is connected to the major desideratum of the human species, namely perpetuation and progress. The psychological dynamics of each and every person is governed by two realities, i.e. optimism and acceptance. This paper proves the existence of a rigid determinism which dictates the tensional psychological dynamics, cancelling free will. The tensional psychological dynamics is also connected every moment to the major desideratum mentioned above. The conscious instance, through its functionality, provides the optimism whereas the unconscious one provides the acceptance. The unconscious instance functions as a receptor, receiving the information from the personalized sense of the person. At the same time and because of this sense, the unconscious instance functions already as a selector of tensional strategies. To describe and prove these aspects, our approach uses the theory of homology.

Brief Biography of the Speaker: Alin Gilbert SUMEDREA, Ph.D in Psychology (1998), Ph.D in Statistics (1993), is Professor at the Faculty of Social-Human Sciences, Lucian Blaga University of Sibiu, ROMANIA. He is also Head of the Psychological Research Centre, Sibiu, ROMANIA.
The scientific activity is represented by 60 published scientific papers and 9 books. Research activity: 17 finalized research projects. He was director for 5 research projects.
Current research interests include: Applications of differential geometry in psychology; Mathematical modelling of psychological processes.

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Plenary Lecture 5

Applying Linear Algebra for Semi-Empirical Modeling in Physical and Economic Systems by Means of Dimensional Analysis

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Abstract: Linear Algebra application under the form of Dimensional Analysis was initially used early in the last century by scientists and engineers for expressing the behaviour of a physical system in terms of the minimum number of independent/explanatory variables/parameters/coefficients (VPCs) and in a mathematical mode that is unaffected by changes in the magnitude of the units of measurement. The first attempt to a similar approach in Economics was made by Allais (1943, 1953), who presented a systematic treatment of the theory of dimensions and its foundations. Later, some researchers, among them the presenter (Batzias et al., 2009), contributed to the diffusion of this scientific topic either for systems analysis by using special Linear Algebra techniques or for checking simulation models by using a properly designed algorithm.
In the present work, a Linear Algebra methodology is introduced under the form of a flow chart, including 24 activity stages and 6 decision nodes, to develop a cyclic/iterative inductive/deductive procedure for modelling physical and economic systems. This methodology, although it produces empirical relations, especially useful to facilitate scale-up/down in chemical engineering and economic growth, uses dimensionless groups expressing ratios with some kind of scientific/economic meaning. As a matter of fact, such relations (if properly selected/synthesized) may serve as knowledge carriers, capable to bridge the gap between an empirical and a corresponding theoretical model; in this sense, the relations, including dimensionless groups, are rather 'grey' than 'black' boxes. The functionality of the methodology presented herein is proved by making reference to three case studies, thoroughly analyzed and discussed within the framework of Linear Algebra and Group Theory.

Brief Biography of the Speaker: Prof. Fragiskos Batzias holds a 5years Diploma and a PhD degree in Chemical Engineering, and a BSc in Economics. He has also studied Mathematics and Philosophy. He is Director of the Laboratory of Simulation of Industrial Processes and Head of the Research Group on Systems Analysis at the Department of Industrial Management and Technology of the University of Piraeus, Greece. He is teaching at the interdepartmental postgraduate courses (i) Systems of Energy Management and Protection of the Environment, running by the University of Piraeus in cooperation with the Chem. Eng. Dept. of the Nat. Tech. Univ. of Athens, and (ii) Techno-Economic Systems, running by the Electr. & Comp. Eng. Dept. of the Nat. Tech. Univ. of Athens in cooperation with the University of Athens and the University of Piraeus. His research interests are in chemical engineering systems analysis and knowledge based decision making. He has >100 publications in highly ranked journals and conference proceedings, including 29 research monographs in collective volumes, with 171 citations and an h-index of 8 (for the period 2004-2012, source: ISI Web of Science, Thompson Scientific; self-citations have been excluded).
He has participated (and chaired after invitation from the organizers) in prestigious international conferences, such as those organized periodically by the IEEE, the European Federation of Chemical Engineering (EFCE), the DECHEMA, CHISA, WSEAS Organizations. He organizes the annual Symposium on Industrial and Environmental Case Studies running successfully since 2004 within the International Conference of Computational Methods in Sciences and Engineering (ICCMSE).

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