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Editorial

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Dealing with the increasing complexity of problems arising in modern science and technology often requires powerful mathematical tools and methodologies. While developments in computer technology allow the solution of incrementally larger problems, it appears that conceptual insights will be necessary to reach the required scale of complexity. An interdisciplinary approach may foster these insights.

The conference series "Mathematical Problems in Engineering, Aerospace, and Sciences" (ICNPAA) aims at bringing together scholars, leading researchers, and experts from diverse backgrounds and application areas. Special emphasis is put on promoting interaction between the theoretical and experimental scientific communities in order to achieve a high-level of exchange in new and emerging areas among engineering, science, and applied mathematics. The conferences in this series have become an important biennial event, attracting many scientists, engineers, and researchers from academia, government laboratories, and industry.

In 1996, 1998 and 2000 the conference was hosted by the Embry-Riddle Aeronautical University at Daytona Beach, Florida (USA). ICNPAA 2002 was held at the Florida Institute of Technology of Melbourne, again in Florida. The three successive meetings took place in Europe: at the West University of Timisoara (Romania) in 2004, at the Budapest University of Technology and Economics (Hungary) in 2006, and at the Faculty of Engineering of the University of Genova (Italy), in 2008. In 2010, the ICNPAA venue was the INPE National Institute for Space Research of São José dos Campos, in Brazil.

This special issue is devoted to a selection of papers containing extended versions of some works presented from June 24 to June 27 at ICNPAA 2008, which hosted about 300 participants from more than 50 countries.

The twelve selected papers deal with a broad spectrum of mathematical problems arising in science and engineering. Some works give methodological contributions, others offer more theoretically-oriented studies, while still a third group focus directly on applications. Topics addressed include control of hydraulic systems, simulation models for thermal and mechanical stress distribution, forecast of freeway traffic conditions to stochastic analysis of investments via Monte-Carlo simulation, structural flexibility of modern flight vehicles, adhesion and decohesion phenomena in mechanics, and flight performance of solar-powered aircraft. Such a wide variety of topics reflects the broad spectrum of the conference.

We hope that this special issue will contribute to fruitful scientific collaboration, stimulate interaction among scientists from a variety of disciplines, and improve the applicability of mathematical methods to challenging problems from engineering and applied sciences.

Finally, we would like to express our thanks to the referees for their careful work and to the authors who submitted their research results.

The paper by S. Balea, A. Halanay, and I. Ursu deals with electro-hydraulic servomechanisms (EHS). The control of hydraulic systems is a challenging task, due to the presence of nonlinearities that arise from properties such as fluid compressibility, complex flow properties of hydraulic valves, and friction characteristic. Most existing models developed for the control design of EHSs for flight control systems neglect the influence of the mounting structure's elasticity on system stability. In this work, the authors investigate the control synthesis in a servoelastic framework, defined by the finite mounting structure stiffness of an EHS. They also address stabilization of the switched system equilibria.

S. Balint and L. Tanasie consider the cutting process into slices for ingots of circular or square cross-sections of certain single crystals produced by melt growth techniques. In particular, they address the edge-defined film-fed growth (EFG) technique. For such a technique, they face the problem of choosing the pressure differences across the outer and inner free surfaces, in order to obtain a stable convex static meniscus with a prescribed size. The dependence of these pressure differences on the composition is investigated.

The Sumudu Transform and some of its applications are the topic of the work by F. B. M. Belgacem. The properties of this recently-developed mathematical tool are investigated, extended, and exploited to deal with Bessel equations. A comparison with the Laplace transform is made and cases in which the Sumudu transform may show advantages over the Laplace are discussed.

The work by S. Bracco describes two simulation models developed in the Matlab/Simulink environment to evaluate the thermal and mechanical stress distribution inside the metal part of a steam drum installed into a heat recovery steam generator of a combined cycle power plant. The models are obtained by applying the Fourier heat conduction equation to calculate temperature values inside both the metal and the insulation of the drum. A finite-difference method is exploited to implement the heat transfer mathematical model. Simulation results concerning the validation phase and the analysis of transient operating conditions of a combined cycle power plant are reported.

In the contribution by R. Leticia Corral-Bustamante, D. Saenz, N.I. Arana, J. A. Hurtado, and B. E. Ochoa, the solution of Newton's equation from classic mechanics is introduced in a relativistic equation obtained from a proposed metric, which solves the differential equations contained in the Einstein's contracted tensor or Riemann-Christoffel's tensor. The results obtained using this approach are compared with relativistic predictions from other authors.

A. Fedi, M. Massabò, O. Paladino, and R. Cianci address the advection-dispersion equation, used to describe the transport of solutes in saturated porous media. A closed-form solution is derived for a two-dimensional semi-infinite domain (parallel plate geometry). This is achieved by an approach based on Fourier series and Laplace transforms, introducing the application of a Jacobi Theta Function. The domain considered in the paper represents a typical experimental device adopted to study solute transport through porous media. To evaluate the influence of the presence of the boundaries on the plume profiles behavior, the solution is compared with a commonly-used one for infinite domain.

F. Maddalena, D. Percivale, and G. Puglisi consider models for adhesion and decohesion phenomena, applied both in traditional problems of mechanics and in modern technological contexts. A parameter playing a major role in macroscopic behavior is the relative strength of the glue or detaching layer and the connected bodies. The authors compare two different approaches that they recently proposed to study the debonding problem of an elastic beam glued to a rigid substrate and subject to a force at one of its end-points. In the first model, a Bernoulli-Navier linearly elastic beam with a decohesion energy depending on the measure of the detached zone is considered. In the second model, the behavior of a discrete lattice of massless points connected by shear springs and by breakable links to a rigid layer is addressed.

The paper by G. Sachs, J. Lenz and F. Holzapfel deals with a model of solar airplane that offers the possibility of an unlimited flight endurance. The solar-powered vehicle is equipped with batteries that can store enough energy for night flight, when no solar radiation is available. The endurance flight method is regarded as a problem of periodic optimal control, in which a single day-night cycle has to be optimized. The goal of an unlimited endurance performance is treated as a trajectory optimization problem. The optimization goal addressed in the paper consists in minimizing the required capacity of the batteries and, thus, in providing a contribution to keep the related weight penalty as small as possible.

G. Sachs and M. Mayrhofer investigate gliding flight which involves jettisoning - an issue for a space transportation system consisting of a winged orbital stage and a carrier stage. Jettisoning is applied for various purposes, one of which is to intentionally decrease the mass of the aircraft. The authors show that the range performance of aerial vehicles in gliding flight can be increased by an optimal application of jettisoning, which is considered as a control and included in the trajectory optimization. Results are demonstrated for two vehicles, one of which relates to the high end of the speed spectrum (orbital stage) while the other applies to the low end (sailplane).

The departure point of the paper by C. Caligaris, S. Sacone, and S. Siri is the classic second-order Payne-Whitham macroscopic model (PW-Model), used to represent and forecast traffic conditions in a freeway. The authors address the problem of choosing suitable sampling intervals for the discretizations required to obtain numerical solutions to the partial differential equations, from which the model comes. Boundaries are defined for sampling intervals, such that the instability of the numerical scheme is avoided. The analysis is applied both to PW-Model and to its extension developed by the authors themselves in a previous work.

The paper by L. Cassettari, P.G. Giribone, M. Mosca, and R. Mosca is motivated by two problems that arise when applying simulation to stochastic analysis of investments: lack of knowledge regarding the experimental error and undervaluation of the mean variance. (Typically, mean variance plays a major role.) The authors develop a methodology to study investments through Monte-Carlo simulation. They define the curve of evolution of the Mean-Square Pure Error in such a way as to optimize the number of experimental runs, and they give scenarios required to achieve a complete vision of the problem under study. The methodology is applied to a realistic case of investment in a production line for a food product.

The work by H. H. Hilton is motivated by the deflection, during flight, of lifting surfaces and fuselages and their skin panels, due the high structural flexibility of modern flight vehicles. The author focuses on panels and their responses to aerodynamic noise. He investigates in terms of order-of-magnitude analysis the nature of loading sources and panel responses to determine their linear or nonlinear contributions. Nonlinear results are evaluated and compared to linear solutions and some numerical simulations are made.

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