From the Guest Editors of Part One

ANALYTICAL METHODS TO NON-LINEAR HEAT TRANSFER AND DIFFUSION

Exact and approximate analytical solutions of diffusion problems concerning heat or mass are well developed and form a classic literature background for any scholar starting in modelling and simulation [1, 2]. Generally, the analytical solutions simplify or reduce the initial models after scaling and establish general relationships upon imposed constrains. In many cases they are the initial stages of refined numerical methods so we have to take into account the deep physical background of the analytical approaches [3]. We focus the attention on analytical techniques for solution of non-linear problems in diffusion of heat, mass and momentum. The collection conveys strong, reliable, efficient, and promising developments of articles on analytical problems and we will try to present briefly the main results.

An approximate solution of one-phase solidification Stefan problem with the unknown time-varying boundary of the region in which the solution is sought is developed in [4]. The method is based on the known formalism of initial expansion of a sought function describing the field of temperature into the power series; the coefficients of the series are determined by solving appropriate differential equations constructed by using the boundary conditions. The solution is compared to a numerical one developed by the boundary element method.

The inverse problems are always hot area in the modelling and the second article of the collection [5] is devoted to an inverse heat conduction problem with Neumann boundary condition solved by the homotopy perturbation method. The determination of the temperature field in the domain and the reconstructions of both the temperature and the heat flux on the boundary employ some *a priori* known temperature values (by measurements in some points of the domain).

A singularity problem of steady-state heat conduction in a semi-infinite medium with two different isothermal surfaces separated by an adiabatic annular disc is solved [6] by using the conformal mapping method based on the Schwarz-Christoffel transformation. It is demonstrated that the thermal resistance can be determined without solving the governing equations and can be presented as a function of the ratio of annular disc radii.

The moving heat source problems are always challenges in modelling of modern technological problems. Hamraoui *et al.* [7] considered a three-dimensional steady-state problem regarding a solid subjected to moving heat sources with non-uniform dissipations of the energies. In this context, the recent Printed Wiring Board embedding technology is the modelling target [8] of Monier-Vinard *et al.* [8]. The suggested analytical approach provides solutions within ±10% of relative error and demonstrate its relevance for modelling high density electronic board.

In heat conduction the damping function represented by a Volterra type integral to model a finite speed of heat was conceived by Cattaneo [9]. The approach constitutes a generalized Fourier's law and a linear superposition of the heat flux and its time derivative related to its history [10]. The integral method of Goodman [11] is successfully applied [12] to heat conduction equation with fading memory expressed by the Jeffrey's kernel [13]. The solution is straightforward and the final form of the approximate temperature profile clearly delineates the "viscous effects" corresponding to the classical Fourier law and the relaxation (fading memory). In the same context, the classical thermodynamic model for near critical heat transfer is an integral-differential equation with constant coefficients and a source term containing the time derivative of the bulk temperature. Leonardo Alves presents an interesting article [14] where the recently suggested Generalized Integral Transform Technique (GITT) [15] is successfully applied to this problem, providing a highly accurate analytical solution for it and a new expression of its relaxation time.

In the heat conduction with a memory, the problem is commonly modelled by the fractional calculus [16]. However, when the domain cannot be described by smooth functions, both the classical homogenization approach and the fractional approach based on Riemann-Liouville (or Caputo) derivatives [16] are unacceptable. In such cases, the local fraction calculus is an efficient modelling technique [17]. The present collection incorporates two articles developing problems in this direction. Yang *et al.* [18] present 1-D heat-conduction in a fractal semi-infinite bar. The solution is developed by the analytical Yang-Fourier transforms of non-differentiable functions [19]. The second article [20] employing the local fractional calculus presents an efficient reconstructive scheme for variational iteration method using the Yang-Laplace transform [17, 19].

The fraction calculus with Riemann-Liouville fractional derivatives [16] combined with the heat-balance integral method [11] is successfully applied to a transient diffusion problem imposed by a non-local integral solution and concerning a redistribution of mass between dissimilar media [21].

Last, escaping from small domains where the previously commented heat and mass diffusion problems were considered, we have in this collection a simplified graphical modeling tool [22] based on Bond Graphs approach focusing on heat transfer in buildings. It can be considered to some extent as either a semi-physically based or a data-driven dynamic model.

This special part of No. 3 of the journal provides a collection of solved problems serving as steps ahead to innovative schemes and elaborated solutions. We hope the articles will provide to the readers new ideas and may be a good source for further inspirations in the thermal science problems.

Last but not least, we like to express our gratitude to all authors who trusted and contributed the collection, the reviewers offering their time to increase the quality of the contents and the editors of the journal *Thermal Science*, as well, for the support of our initiative.

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To cope with this problem, and to make paper processing time shorter, Editorial Board of the journal *Thermal Science* accepted stronger rules for preparing manuscripts. The most important change is that maximum number of pages for scientific papers is now 12 pages (for review papers 20 pages) prepared according Instructions for preparing manuscripts.

New rules for preparing manuscripts are summarized in the following documents:

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Thermal Science – Instructions for preparing manuscripts – 2013, and
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