**Recent Progresses on Fundamentals and Applications of Computational Integral Transforms in Heat and Fluid Flow**

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**ABSTRACT**

The integral transform method is a well-known analytical methodology for the exact solution of linear partial differential equations in mathematical physics, with roots on the separation of variables approach proposed by Fourier, in the first half of the 19th century, on its extension introduced in the work of Koshlyakov, in the first half of the 20th century, and followed by the generalization advanced by Luikov, Olçer, Ozisik, and Mikhailov. Despite its wide use and evolution since then, the classical approach is not directly applicable to a number of *a priori* non-transformable problems, such as most of the nonlinear formulations of interest in transport phenomena. For this reason, this approach was progressively generalized under a more flexible hybrid numerical-analytical structure, known as the Generalized Integral Transform Technique (GITT), which includes all the analytical steps inherent to the classical method, but allow for a flexibilization in the numerical solution of the resulting coupled transformed ordinary differential systems. Since the 1980´s, this computational-analytical methodology was consistently advanced to handle different classes of problems in heat and fluid flow, previously only solvable by purely discrete approaches, offering relative advantages in terms of accuracy, robustness, and computational effort, at the price of further analytical involvement. Not surprisingly, it has been frequently adopted as a benchmarking tool, besides being quite useful as a computational tool on itself in CPU-intensive tasks, such as in inverse problem analysis, optimization, and stochastic simulations.

The present lecture provides a review on the revival and growth of this analytic-based methodology, focusing on recent progresses on both fundamentals and applications. Thus, recently proposed algorithm enhancements such as the single domain formulation, the nonlinear eigenvalue problem base, and the vector eigenfunction expansion are more closely reviewed. Besides, its recent application in selected areas, such as in membrane distillation for water desalination, biodiesel synthesis in micro-reactors, and core flood flow testing of petroleum reservoirs, is illustrated and discussed. Future research needs and extension possibilities are then briefly described.