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UNIFIED INTEGRAL TRANSFORMS ALGORITHM FOR CONVECTION-DIFFUSION IN IRREGULAR GEOMETRIES AND COMPLEX CONFIGURATIONS

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ABSTRACT. This lecture reviews a recently advanced approach based on the Generalized Integral Transforms Technique (GITT) employed in conjunction with a single domain formulation strategy, to provide hybrid numerical-analytical solutions to a wide class of convection-diffusion problems defined in complex physical configurations and irregular geometries, for which an exact analytical solution would otherwise not be readily available. The main concept is to rewrite the flow and energy equations for the different regions or sub-domains of the originally posed problem in the form of a single domain formulation, by making use of space variable coefficients that account for the sub-regions transition, which is then handled by the GITT hybrid solution methodology. Eigenvalue problems containing the space variable coefficients are then proposed to provide the basis of the eigenfunction expansions, and the corresponding eigenfunctions are responsible for recovering the transitional behaviors that are represented within the variable single domain coefficients. Thus, the solution of a generally cumbersome coupled system of partial differential equations written for each individual sub-domain or within irregular regions is avoided, and instead accomplished through integral transformation of an eigenvalue problem from one single formulation for each potential. Applications are selected to illustrate the solution procedure, such as laminar flow within irregularly shaped channels and internal conjugated heat transfer problems. Convergence analysis of the proposed eigenfunction expansions are presented and critical comparisons against classical purely numerical approaches are provided.