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Inverse Prediction of Thermal Parameters of an Annular Hyperbolic Fin Subjected to Thermal Stresses

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Abstract : The closed form solution for thermal stresses in an annular fin with hyperbolic profile is derived using Adomian decomposition method (ADM). The conductive-convective fin with variable thermal conductivity is considered in the analysis. The nonlinear heat transfer equation is efficiently solved by ADM considering insulated convective boundary conditions at the tip of fin. The constant of integration in the solution is to be estimated using minimum decomposition error method. The solution of temperature field is represented in a polynomial form for convenience to use in thermo-elasticity equation. The non-dimensional thermal stress fields are obtained using the ADM solution of temperature field coupled with the thermo-elasticity solution. The influence of the various thermal parameters in temperature field and stress fields are presented. In order to show the accuracy of the ADM solution, the present results are compared with the results available in literature. The stress fields in fin with hyperbolic profile are compared with those of uniform thickness profile. Result shows that hyperbolic fin profile is better choice for enhancing heat transfer. Moreover, less thermal stresses are developed in hyperbolic profile as compared to rectangular profile. Next, Nelder-Mead based simplex search method is employed for the inverse estimation of unknown non-dimensional thermal parameters in a given stress fields. Owing to the correlated nature of the unknowns, the best combinations of the model parameters which are satisfying the predefined stress field are to be estimated. The stress fields calculated using the inverse parameters give a very good agreement with the stress fields obtained from the forward solution. The estimated parameters are suitable to use for efficient and cost effective fin designing.

Keywords : Adomian decomposition, inverse analysis, hyperbolic fin, variable thermal conductivity
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