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INTRINSIC VERIFICATION OF AN EXACT ANALYTICAL SOLUTION IN TRANSIENT HEAT CONDUCTION FOR NUMERICAL CODES VERIFICATION

Giampaolo D'Alessandro[*,§] and Filippo de Monte[*]
[*]Department of Industrial and Information Engineering and Economics,
University of L'Aquila, L'Aquila, Italy
[§]Correspondence author. Email: giampaolo.dalessandro@graduate.univaq.it

ABSTRACT The concept of intrinsic verification is applied to an exact analytical solution to be used for verification of fully-numerical transient heat conduction solvers, based on finite element and finite difference methods. In particular, the addressed problem concerns a finite one-dimensional rectangular body in imperfect thermal contact with a high-conductivity surface layer subject to a jump in heat flux. Once the exact analytical temperature solution is known, it is possible to define a computational analytical solution for short and large times, as well as for a quasi-steady state. The symbolic intrinsic verification of the solution is proven by checking that it satisfies the governing equations, the first law of thermodynamics, and that it reduces to simpler related solutions for special cases. Then, once a computer code is made available, the numerical intrinsic verification is proven by using the concept of penetration time, finite difference schemes, and numerical results from simpler related solutions. Indications of intrinsic verification are obtained, so ensuring a correctness to many significant figures (such as ten or even fifteen), far beyond the accuracy generally practicable from fully numerical solutions.