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Abstract Title: Piecewise linear-in-time approximation of the surface heat flux for solving direct and inverse heat conduction problems

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A piecewise linear-in-time approximation of the surface heat flux for solving direct and inverse heat conduction problems

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ABSTRACT

An approximate method based on superposition of exact analytical solutions is given for solving direct and inverse transient linear heat conduction problems. The starting point is to model the time-varying surface heat flux as piecewise linear (connected line segments).
Solutions constructed using the piecewise linear assumption employ both constant and linear-in-time heat flux-based "building blocks," where the constant basic building block is typical of a piecewise constant profile approximation (stair step variation) of the surface heat flux.
The solution can be interpreted as a numerical approximation of the transient Green's functions solution equation (GFSE) based on a heat flux formulation. The concept of computational analytical solution is used to evaluate the exact analytical building block solutions involved in the superposition to any desired degree of accuracy.
The above superposition is relevant in investigation of inverse heat conduction problems (IHCPs) as it gives a convenient expression for the temperature in terms of the unknown heat flux components.
Some examples of comparison between the proposed piecewise linear profile approximation for the arbitrary-in-time surface heat flux and the well-established piecewise constant profile are given when solving both direct and inverse problems. The combined effect of the accuracy of the basic building block solutions and the number of time steps chosen when discretizing the surface heat flux is also analyzed.
For the sake of completeness, some results when the surface temperature is the boundary condition of interest are provided too.

References

Keith A. Woodbury, Hamidreza Najafi, Filippo de Monte, James V. Beck, *Inverse Heat Conduction: Ill-Posed Problems*, 2nd Edition, 352 pages, John Wiley & Sons, Inc., March **2023**. DOI: 10.1002/9781119840220. Companion site to the Textbook with downloadable MATLAB codes: https://ihc2e.com.