Test Suite for Thermal Problems

Background

Basis of the analysis is the general differential equation for temperature fields (sometimes referred to as the Fourier Equation)

$$\rho \cdot c \cdot \frac{d}{dt} T = \mathrm{div}(\lambda \cdot \mathrm{grad}(T)) + p$$

in the general case for ρ , c , λ , p = f (t, **r**, T(t , **r**)) with **r** = (x,y,z) . ρ , c , λ , p are density, heat capacity, thermal conductivity and heat source density respectively.

Linear Problems

1. One dimensional heat conduction in a zylindrical quartz tube (rather thick-walled) with different temperatures on the inner and outer face. (Actually solved in a 2D region, $\lambda = \mathrm{const} \neq f(t, \mathbf{r}, T)$)
   Files in Example1
   Open question: Is it possible to retrieve the total heat flux through the tube's wall?
2. Non-stationary, one-dimensional temperature profile in an infinite plate subject to a sudden temperature change on it's surfaces (mirror symmetry of the problem is exploited here, $\lambda = \mathrm{const} \neq f(t, \mathbf{r}, T)$). (This is also a lesson in the use of Assign and Init constraints.)
   Files in Example2
   Open question: The Init type constraint is sensitive to the order in which the regions are initiated !?

Nonlinear Problems

3. Stationary state of one-dimensional Copper wire with ends held at 5 and 150 Kelvin.
   $\lambda = \lambda(T)$
   Files in Example3
   Open question: -
4. Stationary state of one-dimensional Copper wire with ends held at 5 and 150 Kelvin and an electrical current passed through it.
   $\lambda = \lambda(T)$, $p = \mathbf{j}^2 \cdot \rho_{el}(T)$
   Files in Example4
   Open questions: How do I set the solution of problem 3 as an initial condition for a non-staionary problem to investigate the behavior after switching on the current (I could not get to work the TransferInitSolution type)?