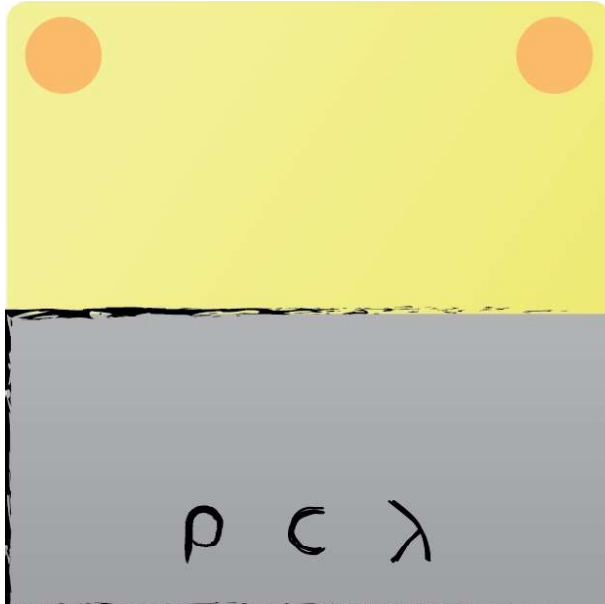


Exam Preparation - Conduction 4



A large body is suddenly imposed to a new temperature at its surface $T(x = 0, t > 0) = 500 \text{ K}$. The body has an initial homogeneous temperature $T(x, t = 0) = 298 \text{ K}$. Determine $T(x_1, t_1)$, for $t_1 = 18 \text{ s}$ at depth $x_1 = 3 \text{ mm}$.

Problem type:

One-dimensional, unsteady-state heat conduction inside a semi-infinite plate with negligible heat transfer resistance.

Temperature profile inside a semi-infinite plate with negligible heat transfer resistance:

$$\Theta^* = \frac{T - T_0}{T_a - T_0} = 1 - \operatorname{erf}\left(\frac{1}{\sqrt{4 \cdot \text{Fo}}}\right)$$



Determining the Fourier number:

$$\text{Fo} = \frac{\lambda \cdot t}{\rho \cdot c \cdot x^2} = 0.1162$$

Determining Θ^* :

$$\Theta^* = 1 - \operatorname{erf}\left(\frac{1}{\sqrt{4 \cdot \text{Fo}}}\right) = 0.0380$$

Rearranging Θ^* and filling in:

$$T = \Theta^* \cdot (T_a - T_0) + T_0 = 306 \text{ K}$$