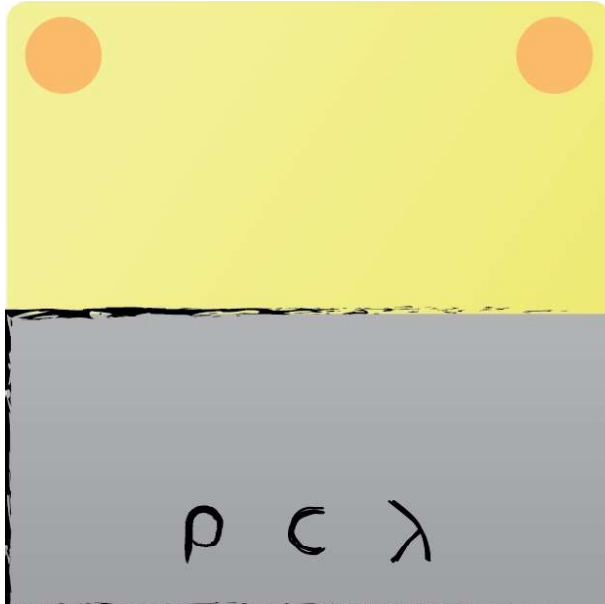


Exam Preparation - Conduction 5



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

$$\text{Fo} = \frac{\lambda \cdot t}{\rho \cdot c \cdot x^2} = 2.6923$$

Determining Θ^* :

$$\Theta^* = 1 - \operatorname{erf}\left(\frac{1}{\sqrt{4 \cdot \text{Fo}}}\right) = 0.6666$$

Rearranging Θ^* and filling in:

$$T = \Theta^* \cdot (T_a - T_0) + T_0 = 433 \text{ K}$$