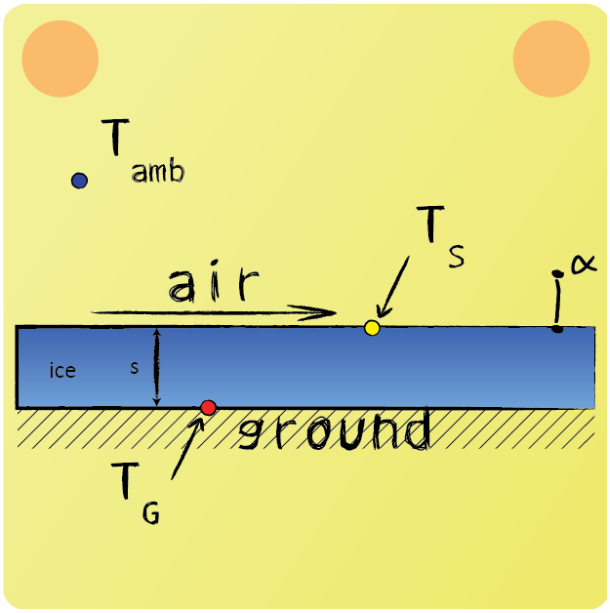
Exam Preparation Conduction 02



A ground is covered with an ice layer of thickness s. Air with the temperature of T_{Amb} is flowing over it. The temperature of the ice at the ground is T_{G} and at the surface T_{S}. The problem is one-dimensional and steady-state. No layer of water is forming at the top of the ice. Determine the thickness s of the ice layer.

The convective heat flow from the surface onto the ice layer is:

$$\dot{Q} = \alpha \cdot A \cdot (T_{\mathrm{amb}} - T_{\mathrm{S}})$$

The conductive heat flow through the ice layer is:

$$\dot{Q} = \frac{\lambda}{s} \cdot A \cdot (T_{\mathrm{S}} - T_{\mathrm{G}})$$

Both heat flows must be identical:

$$\alpha \cdot (T_{\mathrm{amb}} - T_{\mathrm{S}}) = \frac{\lambda}{s} \cdot (T_{\mathrm{S}} - T_{\mathrm{G}})$$

Rearranging and plugging in the numeric values yields the thickness s:

$$s = \frac{\lambda}{\alpha} \cdot \frac{T_{\mathrm{S}} - T_{\mathrm{G}}}{T_{\mathrm{amb}} - T_{\mathrm{S}}} = \frac{2,2}{10} \cdot \frac{-3+10}{5+3}\, m = 0,19\, m$$