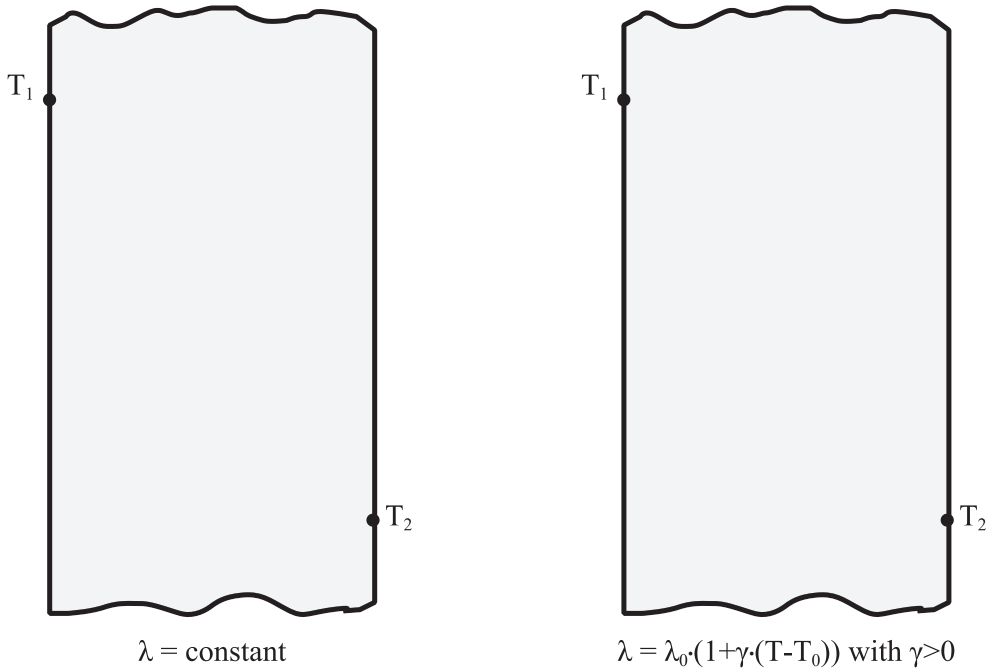
Section II

Conduction exercises

Exercise II.1 (Temperature profiles in planar walls ⋆)**:**

Both sides of a planar wall are heated to a constant temperature of T_1 and T_2, where $T_1 > T_2$.



Tasks:
Qualitatively sketch the temperature profile for steady-state conditions, if

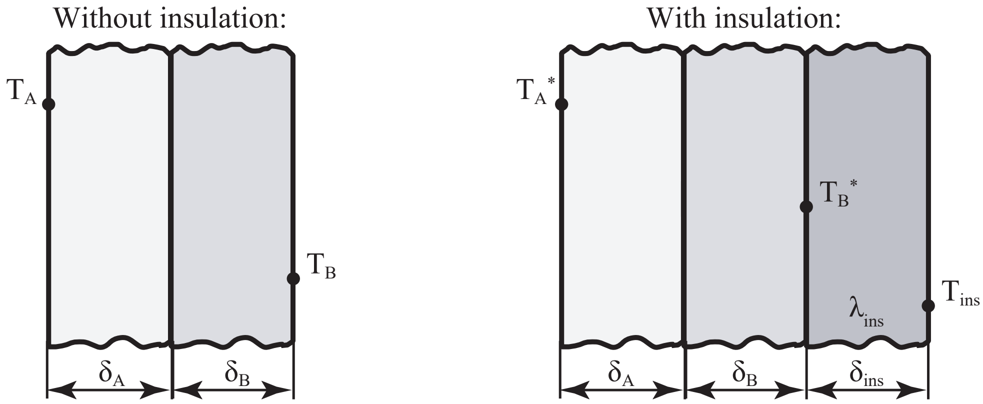
a) the conductivity remains constant

b) the conductivity is a function of the temperature following the equation:

$$\lambda = \lambda_0(1 + \gamma(T - T_0)) \text{ with } \gamma > 0$$
$$(\lambda_0 = \text{thermal conductivity at reference temperature } T_0)$$

Exercise II.2 (Onion layer principle ★★):

A solar panel manufacturer makes use of heat processing applications that include preheating, curing, heat treating, and finishing. The manufacturer has an old and new type of industrial oven. The newer one has an additional insulation layer.



Given parameters:

Old oven:

- Surface temperature of layer A: $T_A = 260$ °C
- Surface temperature of layer B: $T_B = 32$ °C
- Thickness of layer A: $\delta_A = 125$ mm
- Thickness of layer B: $\delta_B = 200$ mm

New oven:

- Surface temperature of layer A: $T_A^* = 305$ °C
- Surface temperature of layer B: $T_B^* = 219$ °C
- Surface temperature of insulation layer: $T_{ins} = 27$ °C
- Thickness of layer A: $\delta_A = 125$ mm
- Thickness of layer B: $\delta_B = 200$ mm
- Thickness of insulation layer: $\delta_{ins} = 25$ mm
- Thermal conductivity of insulation layer: $\lambda_{ins} = 0.075$ W/mK

Hint:

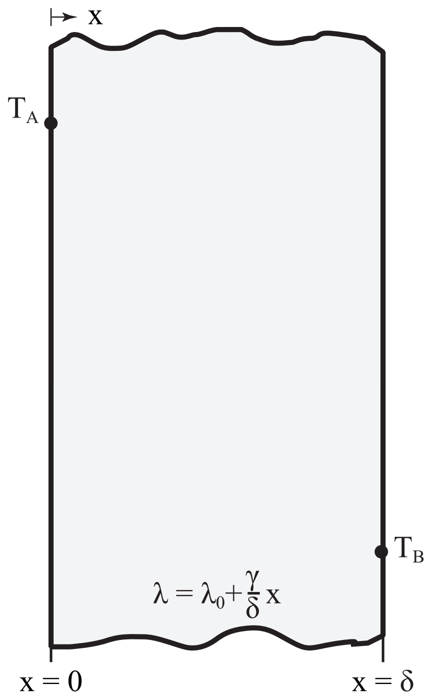
- Assume steady-state conditions.

Tasks:

a) Determine the heat flux per unit area $\dot{q}''$ for the situations without and with the insulating layer.

Exercise II.3 (Heat conduction equation ⋆ ⋆ ⋆)**:**

Both sides of a planar wall are heated to a constant temperature of T_A and T_B, respectively; where $T_A > T_B$.



Given parameters:

- Thermal conductivity as a function of the position in the wall:

$$\lambda(x) = \lambda_0 + \frac{\gamma}{\delta} \cdot x$$

Hints:

- Assume one-dimensional steady-state heat transfer in x-direction.

Tasks:

a) Derive the function of the temperature profile inside the plane wall.

b) Sketch the temperature profile inside the plane wall in the x-direction.