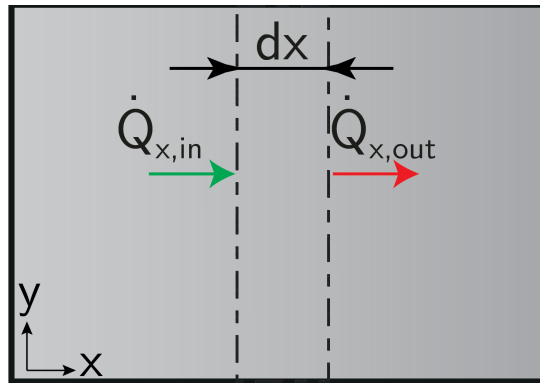# EB - Cond. - IE 3

Setup the energy balance to calculate the one-dimensional steady-state temperature profile inside the wall.

1 **Setting up the balance:**

To derive the one-dimensional steady-state temperature profile, an energy balance around an infinitesimal element is needed. Heat is conducted in and out of the element.

Hence, the steady-state balance reads:

$$\dot{Q}_{\text{x,in}} - \dot{Q}_{\text{x,out}} = 0,$$

the sum of the in- and outgoing fluxes should equal zero, because of steady-state conditions.

2 **Defining the elements within the balance:**

The ingoing flux described by use of Fourier's law:

$$\dot{Q}_{\text{x,in}} = -\lambda A \frac{\partial T}{\partial x},$$

and the outgoing flux is approximated by the use of the Taylor series expansion.

$$\dot{Q}_{\text{x,out}} = \dot{Q}_{x,in} + \frac{\partial \dot{Q}_{\text{x,in}}}{\partial x} \cdot dx$$
$$= -\lambda A \frac{\partial T}{\partial x} + \left(-\lambda A \frac{\partial T}{\partial x} \right) \cdot dx.$$

3 **Inserting and rearranging:**

$$-\lambda A \frac{\partial T}{\partial x} + \lambda A \frac{\partial T}{\partial x} - \frac{\partial}{\partial x} \left(-\lambda A \frac{\partial T}{\partial x} \right) dx = 0,$$

A and λ are constant, hence cancel out:

$$\Rightarrow \frac{\partial^2 T}{\partial x^2} = 0.$$