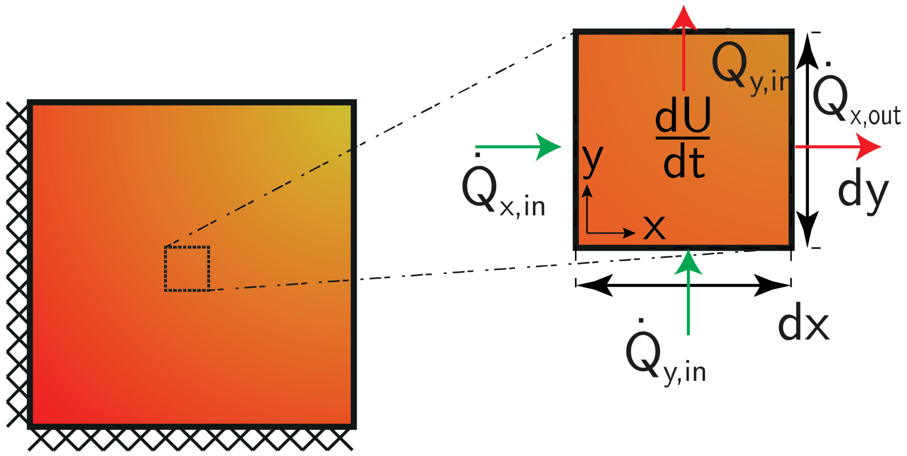
# EB - Cond. - IE 2

**Provide the governing energy balance in the following infinitesimal 2D element in Cartesian coordinates to describe the heat conduction problem in the body without a heat source. Assume the process to be isochoric with transient conditions.**




**Energy balance:**

$$\frac{\partial U}{\partial t} = \dot{Q}_{x,in} - \dot{Q}_{x,out} + \dot{Q}_{y,in} - \dot{Q}_{y,out}$$

For unsteady heat transfer the internal energy will change over time and equals the sum of in- and outgoing heat fluxes.

**Change of internal energy over time:**

$$\frac{\partial U}{\partial t} = \rho \cdot c_v \cdot dx \cdot dy \cdot dz \cdot \frac{\partial T}{\partial t}$$

The internal energy of a constant volume can be described as: $U = m \cdot c_v \cdot T$

**Heat fluxes:**

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

$$\dot{Q}_{y,in} = -\lambda dxdz \frac{\partial T}{\partial y}$$

$$\dot{Q}_{x,out} = -\lambda dydz \frac{\partial T}{\partial x} + \frac{\partial \dot{Q}_{x,in}}{\partial x} dx$$

$$\dot{Q}_{y,out} = -\lambda dxdz \frac{\partial T}{\partial y} + \frac{\partial \dot{Q}_{y,in}}{\partial y} dy$$

The heat fluxes are described by conductive heat transfer. The outgoing heat fluxes can be approximated by use of the Taylor series expansion.