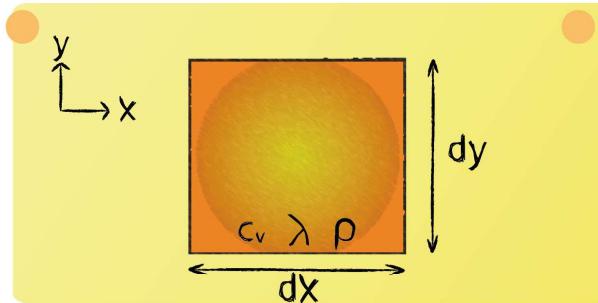


Lecture 3 - Question 5



Assume two-dimensional unsteady state heat transfer without a source. Take $dz = 1m$. Give the energy balance, a description for the change of internal energy over time and a description of the heat fluxes.

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:

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

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



Heat fluxes:

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

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

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

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

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