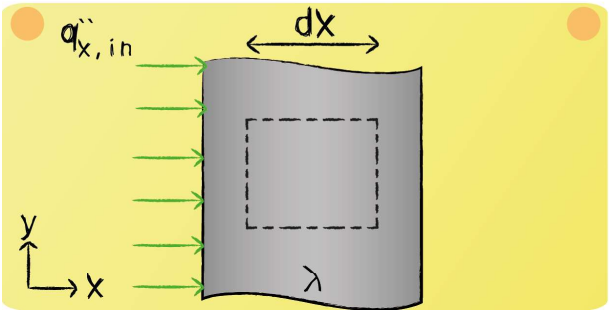
Lecture 14 - Question 7



Give the energy balance, describe the change of the internal energy over time and describe the heat fluxes for the infinitely small control volume. Assume one-dimensional transient heat transfer. The control volume has the dimensions dx,dy and dz

Energy balance:

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

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:

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

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

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