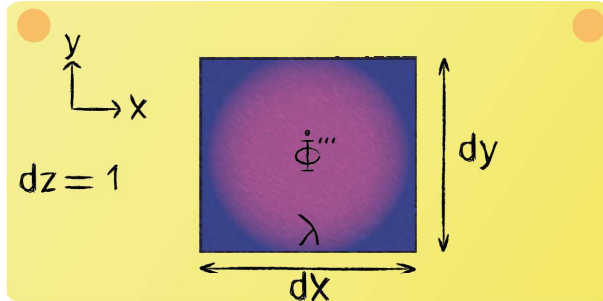# Lecture 2 - Question 5

Give the energy balance to do derive the heat conduction equation. Assume two-dimensional steady state conditions with a source.

Energy balance:

$$\dot{Q}_{x,in} + \dot{Q}_{y,in} - \dot{Q}_{x,out} - \dot{Q}_{y,out} + \dot{\Phi} = 0$$

It is denoted that we are dealing with a source. For that reason the term $\dot{\Phi}$ should be positive.

Heat fluxes:

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

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

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

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

$$\dot{\Phi} = \dot{\Phi}''' \cdot V = \dot{\Phi}''' \cdot dx \cdot dy \cdot dz$$

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