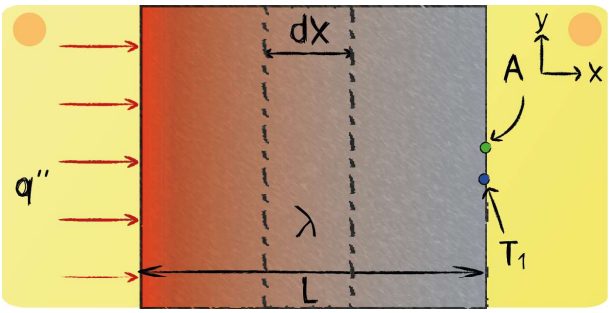
Lecture 2 - Question 7



A constant heat flux is being transferred through a wall. Develop an energy balance to calculate the temperature profile inside the wall and give the boundary condition. Assume steady-state heat transfer in x-direction.

Energy Balance:

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

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 in- and outgoing flux should equal each other. The ingoing flux can be described by use of Fourier's law and the outgoing flux can be described by use of the Taylor series expansion.

Boundary conditions:

$$\frac{\partial T(x=0)}{\partial x} = -\frac{q''}{\lambda}$$

$$T(x = L) = T_1$$

The first boundary condition results from the fact that $\dot{Q}_{x=0} = -\lambda A \frac{\partial T(x=0)}{\partial x} = q'' A$, the second boundary condition results from the fact that the temperature equals T_1 on the right side of the wall.