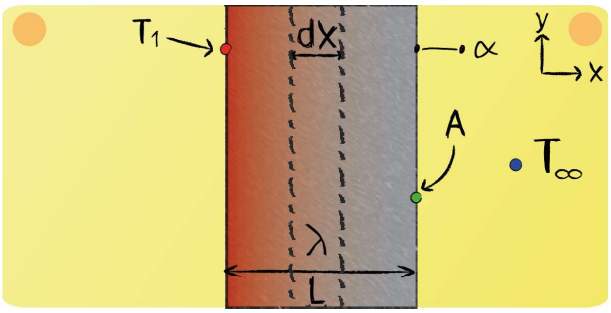
Lecture 6 - Question 6



A wall is subjected to convection. Develop an energy balance to calculate the temperature profile inside the wall and give the boundary conditions. Assume one-dimensional steady-state conditions.

Energy balance:

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

The sum of the in- and outgoing heat fluxes of the control volume should equal zero, because of steady-state conditions.

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 flux entering the control volume can be described by use of Fouriers law. The outgoing heat flux can be approximated by use of the Taylor series expansion.

Boundary conditions:

$$T(x = 0) = T_1$$

$$\frac{\partial T(x=L)}{\partial x} = -\frac{\alpha}{\lambda} \left(T(x = L) - T_\infty\right)$$

The first boundary condition describes that the temperature on the left side equals T_1. The second boundary conditions results from the fact that $\dot{Q}_{x=L} = -\lambda A \frac{\partial T(x=L)}{\partial x} = (T(x = L) - T_\infty)$.