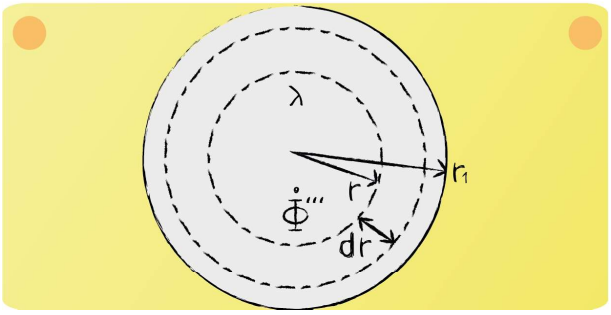
Lecture 13 - Question 6



Give the energy balance and describe the heat fluxes. Assume one-dimensional steady state heat transfer with a source.

Energy balance:

$$\dot{Q}_r - \dot{Q}_{r+dr} + d\dot{Q}_{source} = 0$$

Since the heat transfer is characterized as steady-state, the sum of the in- and outgoing heat fluxes for the control volume should equal zero.

Heat fluxes:

$$\dot{Q}_r = -\lambda \cdot 2 \cdot \pi \cdot r \cdot L \cdot \frac{dT}{dr}$$

$$\dot{Q}_{r+dr} = -\lambda \cdot 2 \cdot \pi \cdot r \cdot L \cdot \frac{dT}{dr} + \frac{d\dot{Q}}{dr} \cdot dr$$

$$d\dot{Q}_{source} = \Phi''' \cdot 2 \cdot \pi \cdot r \cdot L \cdot dr$$

The heat entering the system is transferred from the centre of the cylinder by conductive heat transfer. In the centre of the control volume, heat is generated because of the source. $\dot{Q}_{r+dr}$ can be approximated by use of the Taylor series expansion.