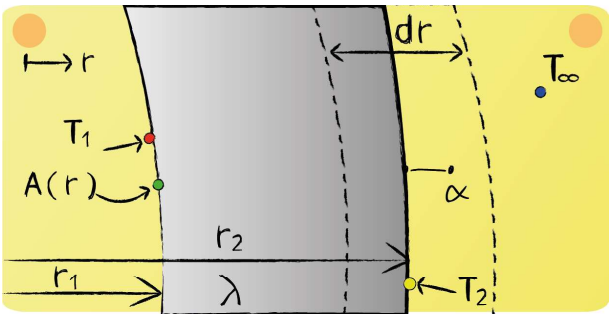
Lecture 8 - Question 6



Develop an energy balance for the infinitesimal element and give the numerical values for the used elements. Take $T_1 = 20\ ^oC$, $T_2 = 10\ ^oC$, $\lambda = 0.01\ W/mK$, $L = 10\ m$, $r_1 = 13\ cm$, $r_2 = 15\ cm$ and $\alpha = 20\ W/m^2K$. Assume steady-state conditions in radial direction.

Energy balance:

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

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

Heat fluxes:

$$\dot{Q}_{r,in} = -\lambda 2\pi L\,(T_2 - T_1)\,\frac{1}{ln\frac{r_2}{r_1}} = -0.01 \cdot 2\pi \cdot 10\,(20 - 10)\,\frac{1}{ln\left(\frac{0.15}{0.13}\right)} = 44\ W$$

$$\dot{Q}_{r,out} = -\lambda 2\pi L\,(T_2 - T_1)\,\frac{1}{ln\frac{r_2}{r_1}} = 44\ W$$

The heat fluxes can be described in terms of conductive heat transfer.