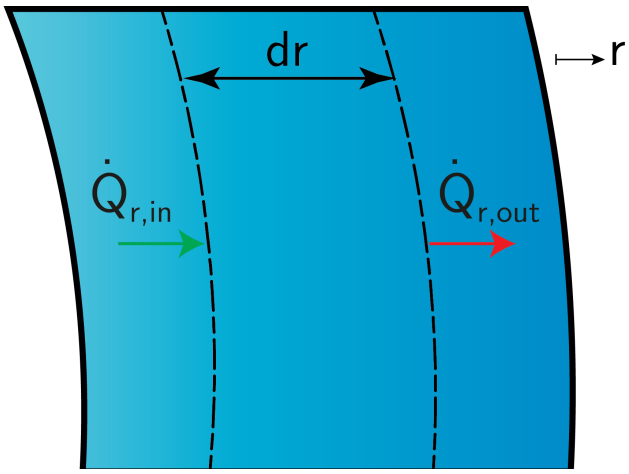
EB - Cond. - IE 7

Develop an energy balance to calculate the temperature profile inside the spherical wall and give the boundary conditions. Assume one-dimensional steady-state heat transfer without sources or sinks 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:

$$\dot{Q}_{r,in} = -\lambda A(r)\frac{\partial T}{\partial r} = -\lambda 4\pi r^2 \frac{\partial T}{\partial r}$$

$$\dot{Q}_{r,out} = \dot{Q}_{r,in} + \frac{\partial \dot{Q}_{r,in}}{\partial r} dr = -\lambda 4\pi r^2 \frac{\partial T}{\partial r} + \frac{\partial}{\partial r}(-\lambda 4\pi r^2 \frac{\partial T}{\partial r})dr$$

The ingoing flux can be described by use of Fourier's law and the outgoing flux can be approximated by use of the Taylor series expansion.

Boundary conditions:

$$T(r = r_1) = T_1$$

$$T(r = r_2) = T_2$$

The boundary conditions describe that on the left side of the cylindrical wall the temperature equals T_1 and on the right side T_2