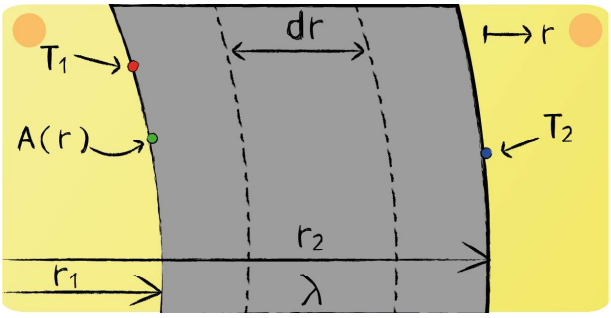
Lecture 5 - Question 5



Develop an energy balance to calculate the temperature profile inside the pipe wall and give the boundary conditions. Assume one-dimensional steady-state conditions. The expansion of the pipe in axial directions is L.

Energy balance:

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

Heat fluxes:

$$\dot{Q}_{r,in} = -\lambda 2\pi r L \frac{dT(r)}{dr}$$

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

In order to obtain the steady-state energy balance, the energy entering and leaving the system should equal each other. Since conductive heat transfer is the only type of heat transfer for this system, the in- and outgoing heat flux can be described by conductive heat transfer in cylindrical coordinates. As the cross sectional surface area changes along the radial coordinate changes, the outgoing heat flux can be approximated by use of the Taylor series expansion

Boundary conditions:

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

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