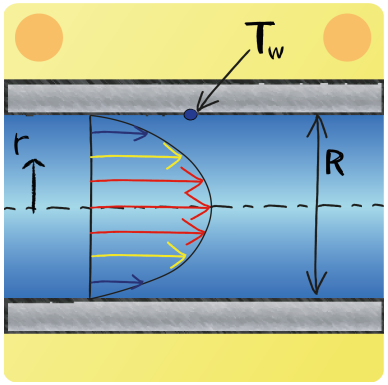
Lecture 9 Question 1

Consider the given differential equation for fully-developed pipe flow with a constant heat flux:
$4\left(r-\frac{r^3}{R^2}\right)\frac{\dot{q}''}{\lambda R}=\frac{\partial}{\partial r}\left(r\frac{\partial T}{\partial r}\right)$
Which boundary conditions are applicable when determining the temperature profile?



Looking at the differential equation, the temperature T has been differentiated twice with respect to r. Implying that when solving the equation, two integration constants have to be defined and therefore two boundary conditions are required.

The first one yields from symmetry in the center, as the slope of the temperature profile over there equals zero. Which can be stated as:

$$\frac{\partial T}{\partial r}|_{r=0}=0$$

The second one yields from the figure, as the temperature at the wall $r=R$ is known to be T_{w}. Which can be stated as:

$$T(r=R)=T_{\mathrm{w}}$$