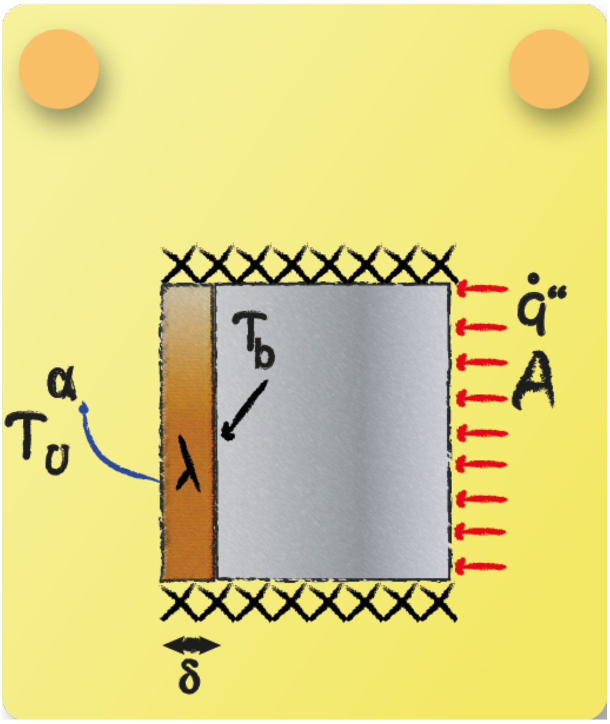
Energy Balance: Task 10



Derive an equation to determine a specific heat flux $\dot{q}''$ to keep a certain constant temperature T_b

Axial heat flux can be expressed in multiple ways:
1. Induced heat flux at the right boundary
2. Conductive heat flux within the left section
3. Convective heat flux at the left boundary

To obtain equations for conductive and convective fluxes, an auxilliary temperature T_a is introduced, which represents a further unknown. By those expressions, two equations can be formed:

$$\dot{q}''A = A\lambda\frac{T_\mathrm{b}-T_\mathrm{a}}{\delta}$$
$$\dot{q}''A = A\alpha(T_\mathrm{a}-T_\mathrm{u})$$

1 Cancelling out T_a one obtains an equation to determine $\dot{q}''$ that may be formulated as one of the three following equations:

$$\dot{q}'' = \alpha(T_\mathrm{b} - \frac{\dot{q}''\delta}{\lambda} - T_\mathrm{u})$$
$$\dot{q}'' = \frac{\lambda}{\delta}(T_\mathrm{b} - T_\mathrm{u} - \frac{\dot{q}''}{\alpha})$$
$$\dot{q}'' = \frac{T_\mathrm{b}-T_\mathrm{u}}{\frac{1}{\alpha}+\frac{\delta}{\lambda}}$$

The easiest way to derive the latter arrangement after all is to express the heat flux via heat resistances such that no additional temperature T_a is needed:

$$\dot{Q} = \frac{\Delta T}{W_\mathrm{conductive}+W_\mathrm{convective}}$$