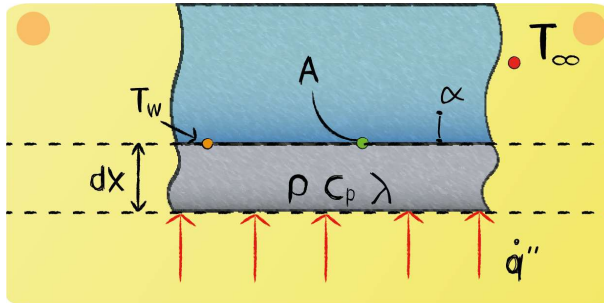# Lecture 14 - Question 11

A pan of water is heated by means of a conduction plate, which provides a constant heat flux. Heat from the pan towards the water is transferred by means of convection. Derive the differential equation that expresses the change in temperature of the pan over the course of time. Assume the pan temperature to be homogeneous and neglect radiation.

Energy balance:

$$\frac{dU}{dt} = \dot{Q}_{in} - \dot{Q}_{out}$$

The heat transfer can be classified as transient, for that reason the change of internal energy over time equals the sum of the in and outgoing fluxes.

Change of internal energy over time:

$$\frac{dU}{dt} = \rho \cdot c_p \cdot A dx \cdot \frac{dT_w}{dt}$$

The internal energy of the control volume can be described as: $U = m \cdot c_{\mathrm{p}} \cdot T$.

Heat fluxes:

$$\dot{Q}_{in} = \dot{q}'' A$$

$$\dot{Q}_{out} = \alpha A \left(T_w - T_\infty \right)$$