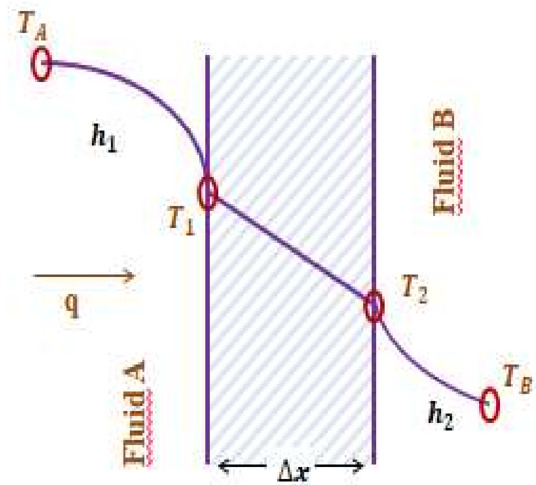
CEN 3311 HEAT TRANSFER

The overall heat transfer coefficient (U)

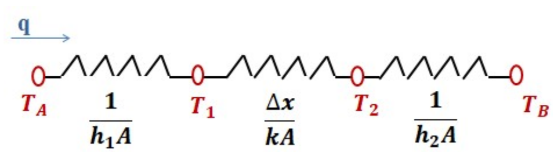
- **Plane wall**: Consider the plane wall shown in figure.

- The heat transfer transfer rate is expressed as follows:

$$q = h_1 A(T_A - T_1) = \frac{kA}{\Delta x}(T_1 - T_2) = h_2 A(T_2 - T_B)$$



The overall heat transfer is calculated as the ratio of the overall temperature difference to the sum of the thermal resistences:



$$q = \frac{T_A - T_B}{\frac{1}{h_1 A} + \frac{\Delta x}{kA} + \frac{1}{h_2 A}}$$

$$q = \frac{A(T_A - T_B)}{\frac{1}{h_1} + \frac{\Delta x}{k} + \frac{1}{h_2}}$$

→ **Total resistence**

Here, the denominator is total thermal resistance and combined of convective and conductive resistances.

On the other hand, the overall heat transfer is frequently expressed in terms of an overall heat transfer coefficient, U:

$$\boldsymbol{q = UA\Delta T_{overall}}$$

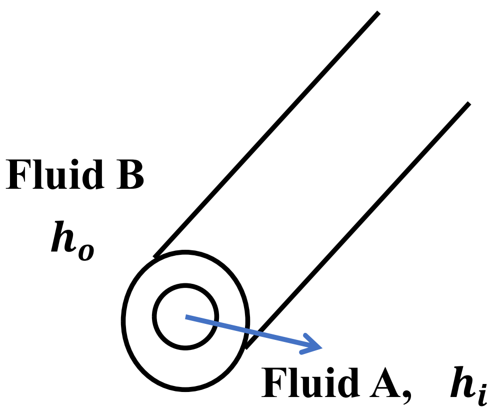
Here, A is some suitable area for the heat flow.

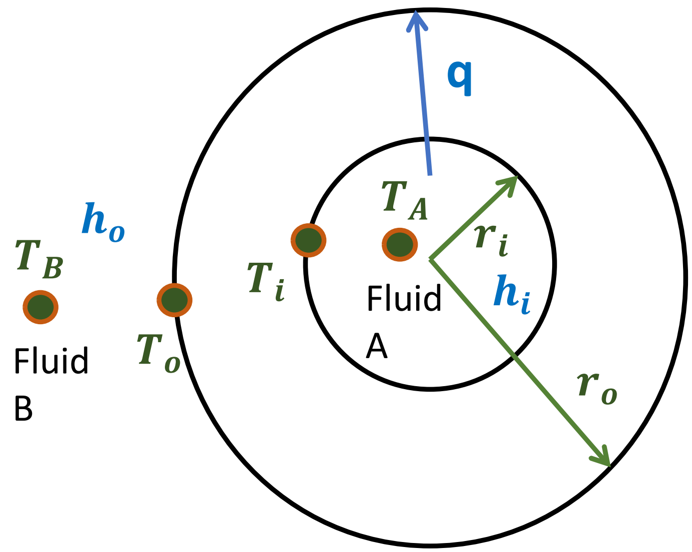
Combining the equations gives:

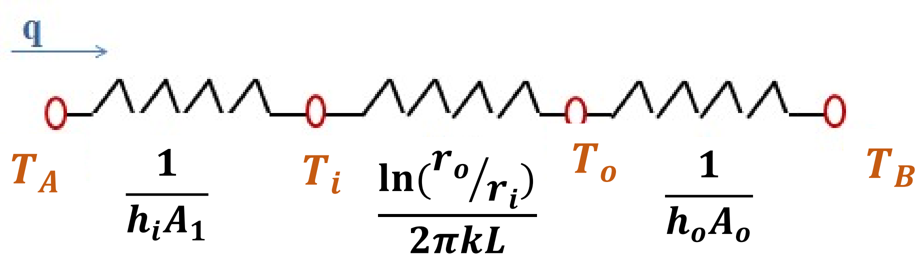
$$\boldsymbol{U = \frac{1}{\frac{1}{h_1} + \frac{\Delta x}{k} + \frac{1}{h_2}}}$$

Overall heat transfer coefficient for a plane wall

- **Cylinder**: Consider a hollow cylinder is exposed to a convection environment on its inner and outer surfaces as shown in figure.







$A_i \rightarrow$ inside surface area of the tube

$$A_i = \pi D_i L$$

$A_o \rightarrow$ outside surface area of the tube

$$A_o = \pi D_o L$$

Since there are two surface area, the overall heat transfer coefficient may be written either for inside surface area or for outside surface area.

$$q = \frac{(T_A - T_B)}{\frac{1}{h_i A_i} + \frac{\ln(r_o/r_i)}{2\pi k L} + \frac{1}{h_o A_o}}$$

$$q = U_i . A_i . \Delta T_{overall}$$

$$U_i = \frac{1}{\frac{1}{h_i} + \frac{A_i \ln\left(\frac{r_o}{r_i}\right)}{2\pi k L} + \frac{A_i}{A_o}\frac{1}{h_o}}$$

or

$$q = U_o . A_o . \Delta T_{overall}$$

$$U_o = \frac{1}{\frac{A_o}{A_i}\frac{1}{h_i} + \frac{A_o \ln\left(\frac{r_o}{r_i}\right)}{2\pi k L} + \frac{1}{h_o}}$$