Examples

1. A surface area of 2 m² has a steady, uniform temperature of $T_{S,out}$ = 13°C and an emissivity of ε = 0.93. The temperature of the surroundings to which this surface radiates is 268 K. Find the net radiation heat transfer (in W) from the surface to the surroundings.

2. Concurrently, air at 10°C blows over the surface. The resulting convective heat transfer coefficient is h = 20 W/m²-K. Find the convection heat transfer (in W) from the surface to the air.

3. The surface is actually a makeshift roof of a clubhouse. The roof material is 13 mm thick, and the *inside* temperature is $T_{S,in}$ =25°C. Assuming that heat transfer through the roof is one-dimensional and steady, find the thermal conductivity (in W/m·K) of the roof material.

1) $\dot{Q}_{rad} = \varepsilon \sigma A (T_{s,out}^4 - T_{surr}^4)$

$= (0.93)(5.67 \times 10^{-8} \frac{W}{m^2 \cdot K^4})((13+273)^4 - 268^4) K^4 =$

$= \boxed{162 W}$

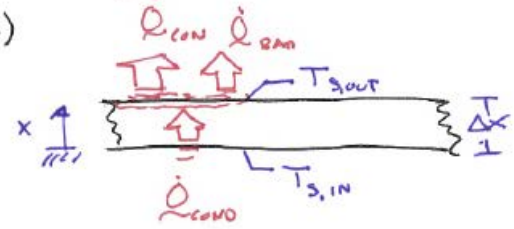
2)

$\dot{Q}_{CONV} = hA(T_{s,out} - T_{AIR})$

$= (20 \frac{W}{m^2 \cdot K})(2 m^2)(13 - 10)°C$

$= \boxed{120 W}$ HOW?

3)



ENERGY BALANCE ON ROOF SURFACE

$\frac{d}{dt}(E) = \dot{Q}_{NET} + / \quad + / \; - /$

$\rightarrow 0$

$0 = \dot{Q}_{COND} - \dot{Q}_{CONV} - \dot{Q}_{RAD}$

$\dot{Q}_{COND} = -kA \frac{dT}{dx}$

$= -kA \frac{T_{s,out} - T_{s,IN}}{\Delta x}$

$k = \frac{\dot{Q}_{CONV} + \dot{Q}_{RAD}}{T_{s,IN} - T_{s,out}} \frac{\Delta x}{A}$

$= \ldots = \boxed{0.153 \; W/m \cdot K}$