SECOND WEEK ASSIGNMENT

1 **Write a summary about the convective heat transfer (half a page) and explain why increasing the thickness of a single pane glass does not increase the total resistance**

CONVECTIVE HEAT TRANSFER:

Convection refers to the heat transfer from fluid to a solid or a solid to a fluid. For example: When there is a hot vessel on in the kitchen, we feel the heat just around the vessel too. This is because molecules of air closest to the vessel have been warmed because of molecules of the vessel. This exchange of warmth is called thermal heat transfer. There are two types of convection: Natural and Forced. Natural convection happens when there is no external force for the movement of air. In natural convection, warmer air rises, as It is less dense and lighter, making the cool air come down, due to its density and heaviness. This type of convection is what we normally see at houses, assuming all outlets are closed and there is no inlet of air from outside. Forced Convection happens in the presence of external forces such as a fan, air conditioner, wind, etc. For windows with a single pane glass, the resistance of glass is as given below.

$$R_g = \frac{L}{(K \times A)}$$

We understand from the formula that width(L) of the single pane glass is directly proportional to the resistance it offers, but it should be noted that the factors K and A are much bigger than any L provided and does not alter the value of R significantly. Therefore, no matter how much we increase the thickness of glass, the resistance offered by glass is going to be small. However, if we introduce a new medium in the making of windows, the resistance goes higher. This is the air gap present between two layers of glass. Assuming the air gap sandwiched between the glass panels does not experience convection and only conduction.

2 write an explanation about what mistakes you made in the class that resulted in wrong answers !!

ANSWER:

1. For the problems, I had considered only up to 2 decimal points leading to a different answer than discussed in class.
2. While equating equations, change of signs was forgotten.
3. In the Glass-air-glass problem, did not account for the inside temperature and outside temperature.

3 solve the same problem as that of double pane window with the air-gap thickness of 13 mm and glass thickness of 6 mm, comment on your results and explain why we have an optimal range for the air-gap's distance !

Consider a 0.8-m-high and 1.5-m-wide double-pane window consisting of two 6-mm-thick layers of glass (k= 0.78 W/m.°C) separated by a 13-mm-wide stagnant air space (k= 0.026 W/m.°C). Determine the steady rate of heat transfer through this double-pane window and the temperature of its inner surface.

Take the convection heat transfer coefficients on the inner and outer surfaces of the window to be h1= 10 W/m2 · °C and h2=40 W/m2 · °C, which includes the effects of radiation.

ANSWER:

A= 0.8m x 1.5m=1.2m

$$R_{g_1} = R_{g_2} = \frac{L_g}{(K_g \times A)} = \frac{0.006}{0.78 * 1.2} = 0.0064\,° \frac{C}{W}$$

$$R_{airGap} = \frac{L_{airGap}}{(K_{airGap} \times A)} = \frac{0.013}{0.026 * 1.2} = 0.4167\ °C/W$$

$$R_{conv_1} = \frac{1}{\mathrm{h}_1 \times A} = (\frac{1}{10 * 1.2)} = 0.0833\ °C/W$$

$$R_{conv_2} = \frac{1}{\mathrm{h}_2 \times A} = (\frac{1}{40 * 1.2)} = 0.0208\ ° \frac{C}{W}$$

$$R_{tot} = R_{conv_1} + R_{conv_2} + 2 \times R_g + R_{airGap} = 0.5336° \frac{C}{W}$$

$$\dot{Q} = \frac{\Delta T}{R_{Tot}} = \frac{20 - (-10)}{0.5336} = 56.22W$$

$$\dot{Q} = \frac{T_{inff_1} - T_{s_1}}{R_{conv_1}} = \rightarrow 56.22 = \frac{20 - T_{s_1}}{0.0833} \rightarrow T_{S_1 = 15.3\ °C}$$

Resistance of air gap is much higher that the resistance offered by the glass and the convection inner and outer surface. The presence of only glass gives 0.0064$° \frac{C}{W}$ of resistance, whereas with the presence of a 13mm wide airgap the total resistance goes up to 0.5336 $° \frac{C}{W}$.

Also, it can be assumed that by increasing the width of the airgap, we can increase the thermal resistance. But this assumption is not true because as we increase the airgap, we allow for the air to be influenced by natural convection and therefore does not result in the increment of thermal resistance.