# Assignment 3

## Question 1

Complete the modified example of simplified wall calculations that you went through in the assignment of week 3 and find the total heat transfer through wall.

*A wood frame wall that is bulid around 38-mm 90-mm wood studs with a center-to- center distance of 400 mm. The 90-mm wide cavity between the studs is filled with urethane rigid foam insulation. The inside is finished with 13-mm gypsum wallboard and the outside with 13-mm polywood and 13 mm 200mm wood bevel lapped siding. The insulted cavity constitutes 75 % of the heat transmission area while the studs, plates and sills constitute 21 percent. The headers constitute 4 percent of the area and they can be treated as studs.*

*Find the two $R_{unit}$ values.*

| | Wood | Insulation |
|---|---|---|
| Outside air | 0.03 | 0.03 |
| Wood Bevel | 0.14 | 0.14 |
| Urethane Rigid Foam | / | (0.98/25)x90 = 3.53 |
| Polywood | 0.11 | 0.11 |
| Gypsum Board | 0.079 | 0.079 |
| Inside surface | 0.12 | 0.12 |
| Wood Studs | 0.63 | / |

$R'_{wood}$ = 0.03 + 0.14+ 0.11 + 0.079 + 0.12 + 0.63 = 1.11 $\frac{\mathrm{m2 \cdot °C}}{W}$

$R'_{insulation}$ = 0.03 + 0.14 + 3.53 + 0.11 + 0.079 + 0.12 = 4.01 $\frac{\mathrm{m2 \cdot °C}}{W}$

$$\mathrm{U_{tot}} = \mathrm{U_{ins}} * \frac{\mathrm{A_{ins}}}{\mathrm{A_{tot}}} + \mathrm{U_{wood}} * \frac{\mathrm{A_{wood}}}{\mathrm{A_{tot}}}$$

$$\mathrm{U_{tot}} = \mathrm{U_{ins}} * 0.75 + \mathrm{U_{wood}} * 0.25$$

$$\mathrm{U_{ins}} = \frac{1}{\mathrm{R'_{ins}}} = \frac{1}{4.01} = 0.2494 \ \frac{\mathrm{W}}{\mathrm{m^2°C}}$$

$$\mathrm{U_{wood}} = \frac{1}{\mathrm{R'_{wood}}} = \frac{1}{1.11} = 0.9009 \ \frac{\mathrm{W}}{\mathrm{m^2°C}}$$

$$U_{tot} = 0.2494 * 0.75 + 0.9009 * 0.25 = 0.18705 + 0.225225 = 0.412275 \frac{W}{m^2 °C}$$

$$A_{tot} = 50 * 2.5 * 0.8 = 100 m^2$$

$$\Delta T = 22 - (-2) = 24 °C$$

$$Q_{tot} = U_{tot} * A_{tot} * \Delta T = 989.46 W$$

## Question 2

In 2 pages you should write a summary of what you have learnt in this session about radiation and radiative heat transfer.

Radiation is the transmission of energy by electromagnetic waves. In general, radiation is energy that moves from one place to another. Thermal radiation is the electromagnetic radiation that bodies emit at a certain temperature. The first results on thermal radiation were given by Joseph Stefan, Ludwig Boltzmann and Wilhelm Wien.

Conduction and convection require material medium to transfer heat. Radiation is a method of heat transfer that does not depend on any contact between the heat source and the heated object. Radiation heat tranfer cana s well occur in solids, liquids and gases.

We can feel heat from the Sun even though we are not in contact with it. Heat can be transmitted though empty space by thermal radiation. Thermal radiation is a electromagnetic radiation ( a light). No mass is exchanged and no medium is required.

Objects emit radiation when high energy electrons in a higher atomic level fall down to lower energy levels. The energy lost is emitted as light or electromagnetic radiation. All objects absorb and emit radiation. When the absorption of energy balances the emission of energy, the temperature of an object stays constant. If the absorption of energy is greater than the emission of energy, the temperature of an object rises. If the absorption of energy is less than the emission of energy, the temperature of an object decreases.

Radiation ca be natural or made by humans. We are exposed to natural radiation every day from soil and underground gases to radiation from the Sun. Our bodies are also exposed to radiation from our own inventions: medical procedures, televisions, cell phones and microwaves etc. Radiation can be dangerous but that is not always the case. It depends on its strength, type and the length of exposure.

A medium that emits radiation that can be visible is called a light source. The biggest and most important natural light source is the Sun and it represents the primary light source. Electromagnetic radiation that Sun produces is also known as solar radiation. The majority of the solar radiatio is light (visible) and other parts include utraviolet and infrared light.

Humans cannot see the ultraviolet (UV) lights and are the biggest reason our skin can get sunburned. They are to be avoided since they can be very dangerous on humans and other beings.

Black Body

Bodies that radiate energy into the environment are constantly receiving energy from the environment. If the body and its environment are at the same temperature, then energy is emitted equal to the energy absorbed. The body and environment are in a state of dynamic equilibrium. Different bodies produce different amount of radiation. Bodies that emit heat well absorb it as well.

One of the best examples is black body -it completely absorbs all the radiation that falls on it. Moreover, it is an ideal body that emits and absorbes radiation.