Week4 Assignment

Question1：

Determine the overall unit thermal resistance (the R-value) and the overall heat transfer coefficient (the U-factor) of a wood frame wall that is built 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. The inside is finished with 13-mm gypsum wallboard and the outside with 13-mm plywood and 13-mm 200-mm wood bevel lapped siding. The insulated cavity constitutes 75 percent 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(this means 75% of area is insulation and 25% can be considered wood).

Answer：

Wood:		**Insulation:**	
Outside Surface :	0.03	Outside Surface:	0.03
Wood Bevel:	0.14	Wood Bevel:	0.14
Plywood:	0.11	Plywood:	0.11
Urethane Rigid Foam:	No	Urethane Rigid Foam:	0.98*90/25=3.528
Wood Studs:	0.63	Wood Studs:	No
Gypsum Wallboard:	0.079	Gypsum Wallboard:	0.079
Inside Surface:	0.12	Inside Surface:	0.12

$$R'_{with.wood} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.109(°C/W)$$

$$R'_{with.insulation} = 0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12 = 4.007(°C/W)$$

$$\frac{1}{R_{total}} = \frac{1}{R_{wood}} + \frac{1}{R_{ins}}, \quad R' = R \bullet A, \quad R = \frac{R'}{A}, \quad U \bullet A = \frac{1}{R_{total}}, \quad U = \frac{1}{R'},$$

$$U_{wood} = \frac{1}{R'_{wood}} = \frac{1}{1.109} \approx 0.9017(°C/W)$$

$$U_{insulation} = \frac{1}{R'_{insulation}} = \frac{1}{4.007} \approx 0.2496(°C/W)$$

$$U_{total} = U_{wood} \times \frac{A_{wood}}{A_{total}} + U_{ins} \times \frac{A_{ins}}{A_{total}} = 0.9017 \times 0.25 + 0.2496 \times 0.75 = 0.4126(°C/W)$$

$$R_{total} = \frac{1}{U_{total}} = \frac{1}{0.4126} \approx 2.4237(°C/W)$$

$$\dot{Q}_{total} = U_{total} \times A_{total} \times \Delta T = 0.4126 \times 50 \times 2.5 \times (1 - 20\%) \times [22 - (-2)] = 990.24(W)$$

Question2：

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

Summary about radiation and radiative heat transfer

Radiative heat transfer and thermal transfer are commonly used to describe the science of the heat transfer caused by electromagnetic waves. The strength and wavelengths of emission depend on the temperature of the emitting material. As we shall see, for heat transfer applications wavelengths between 10^{-7}m and 10^{-3}m are of greatest importance. Thermal transfer is transferred by electromagnetic waves, or photons, which may travel over a long distance without interacting with a medium. Radiative heat transfer becomes more important with rising temperature levels and may be totally dominant over conduction and convention at very high level. Thermal radiation is a volumetric phenomenon. However, for opaque solids such as metals, radiation is considered to be a surface phenomenon, since the radiation emitted by the interior region never reach the surface.

A blackbody is defined as a perfect emitter and absorber of radiation. At a specified temperature and wavelength, no surface can emit more energy than a blackbody.