ZHANG XIAOXUAN 10710452

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 insulation**. The inside is finished with 13-mm gypsum wallboard and the outside with 13 mm wood **playwood** 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) .

Also, determine the rate of heat loss through the walls of a house whose perimeter is 50 m and wall height is 2.5 m in Las Vegas, Nevada, whose winter design temperature is -2 C. Take the indoor design temperature to be 22 C and assume 20 percent of the wall area is occupied by glazing.

ANSWER:

	Wood	Insulation
Outside air	0.03	0.03
Wood bevel lapped siding	0.14	0.14
Plywood(13mm)	**0.11**	**0.11**
Urethane rigif foam	**NO**	**0.98*90/25=3.528**
Wood studs(90mm)	0.63	NO
Gypsum board(13mm)	0.079	0.079
Inside surface	0.12	0.12

$A = 50 * 2.5 * 0.8 = 100\ m^2,\ \Delta T = 22 - (-2) = 24°C$

$R_{withwood}$=0.03+0.14+0.11+ 0.63+0.079+0.12=1.109 ㎡·℃/W

$R_{withins}$=0.03+0.14+0.11+3.528+ 0.079+0.12=4.007 ㎡·℃/W

$$\frac{1}{R_{total}} = \frac{1}{R_{wood}} + \frac{1}{R_{ins}}$$

$$R' = R \times A \rightarrow R = \frac{R'}{A}$$

$$\frac{1}{\frac{R'_{total}}{A_{tot}}} = \frac{1}{\frac{R'_{wood}}{A_{wood}}} + \frac{1}{\frac{R'_{ins}}{A_{ins}}} \rightarrow$$

$$\frac{A_{tot}}{R'_{total}} = \frac{A_{wood}}{R'_{wood}} + \frac{A_{ins}}{R'_{ins}}$$

$$\frac{1}{R'} = U$$

$$U_{tot} \times A_{tot} = U_{wood} \times A_{wood} + U_{ins} \times A_{ins}$$

$$U_{tot} = U_{wood} \times \frac{A_{wood}}{A_{tot}} + U_{ins} \times \frac{A_{ins}}{A_{tot}} = 0.25 \times U_{wood} + 0.75 \times U_{ins}$$

$$= 0.25 \times \frac{1}{R'_{wood}} + 0.75 \times \frac{1}{R'_{ins}}$$

$$= 0.25 \times \frac{1}{1.109} + 0.75 \times \frac{1}{4.007} = 0.25 \times 0.9017 + 0.75 \times 0.2496$$

$$= 0.4126 \frac{W}{m^{2\circ}C}$$

$$R_{tot} = \frac{1}{U_{tot}} = \frac{1}{0.4126} = 2.4237 \frac{m^{2\circ}C}{W}$$

$$Q_{tot} = U_{tot} \times A_{tot} \times \Delta T = 0.4126 \times 100 \times 24 = 990.24\, W$$

QUESTION 2:

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

SUMMERY:

Radiation

Everything in the nature, as long as the temperature is above absolute zero, is constantly transmitted in the form of electromagnetic waves and particles. This way of transmitting energy is called radiation. While scattering the emitted radiant energy, the object will continuously absorb the radiant energy emitted by other surrounding objects and convert it into heat energy.

The electromagnetic waves are affected by their frequency or wavelength. Electromagnetic radiation is viewed as the propagation of a collection of discrete packets of energy "photons or quanta". The energy of a photon is inversely proportional to its wavelength.

Radiative heat transfer

The heat transfer process between the objects that emits and absorbs radiant energy is called radiative heat transfer. It is a non-contact heat transfer that can also be carried out in a vacuum. If the radiation heat transfer is between two objects with different temperatures, the high temperature object will transfer the heat to the low temperature object. If the temperature of the two objects is the same, the radiation transfer variable between the objects is equal to zero, but the process of radiation and absorption is still ongoing. The strength of the radiation can be measured by the temperature, the rate of emission increases with the increasing temperature. Unlike conduction and convection, heat transfer by thermal radiation does not necessarily need a material medium for the energy transfer. In the case of thermal radiation from a solid surface, the medium through which the radiation passes could be vacuum, gas, or liquid.

The spectrum of thermal radiation is a continuum, and the wavelength coverage can theoretically range from 0 to ∞. The general thermal radiation mainly depends on the longer wavelength visible light and infrared rays. Visible light is the part of the electromagnetic spectrum that the human eye can perceive, which lies between 400 and 760 nm. An object that emits light by itself and is emitting light is called a light source, and the sun is our main light source. The electromagnetic radiation emitted by the sun is known as solar radiation, including visible light mostly , ultraviolet and infrared. Ultraviolet rays , accounting for about 12 percent of solar radiation, need to be isolated since they can kill microorganisms and cause serious damage to the skin of humans and other living beings. The ozone layer in the atmosphere acts as a protective barrier and absorbs most of this ultraviolet radiation.

A black body is a surface that absorbs all incident radiation and reflects none . It emits the maximum amount of radiation by a surface at a given temperature. Given by Wien’s displacement law: at a certain temperature, the product of the absolute black body temperature and the wavelength corresponding to the maximum radiation power is a constant. When the temperature of the absolute black body rises, the replacement of the radiation power moves toward the short wave direction.