WEEK 4

QUESTION 1

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 rigif 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)*

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.

	Wood	Insulation
Outside Air	0.03	0.03
Wood Bevel (13mm*200mm)	0.14	0.14
Polywood(13mm)	0.11	0.11
Urethane Rigif Foam Ins. (90mm)	No	3.528
Wood Studs(90mm)	0.63	No
Gypsum Borad(13mm)	0.079	0.079
Inside Surface	0.12	0.12

$$R'_{withwood} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.109\frac{m^2\,℃}{W}$$

$$R'_{withinsulation} == 0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12 = 4.007\frac{m^2\,℃}{W}$$

$$\because \frac{1}{R_{total}} = \frac{1}{R_{withwood}} + \frac{1}{R_{withinsulation}}$$

$$R'_{withwood} = R_{withwood} \cdot A_{withwood}, \quad R'_{withinsulation} = R_{withinsulation} \cdot A_{withinsulation}$$

$$R'_{total} = R_{total} \cdot A_{total}$$

$$\therefore \frac{A_{total}}{R'_{total}} = \frac{A_{withwood}}{R'_{withwood}} + \frac{A_{withinsulation}}{R'_{withinsulation}}$$

$$\because U_{withwood} = \frac{1}{R'_{withwood}}, U_{withinsulation} = \frac{1}{R'_{withinsulation}}, U_{total} = \frac{1}{R'_{total}}$$

$$\therefore A_{total} \cdot U_{total} = A_{withwood} \cdot U_{withwood} + A_{withinsulation} \cdot U_{withinsulation}$$

Divide everything by A_{total}

$$\therefore U_{total} = \frac{A_{withwood}}{A_{total}} \cdot U_{withwood} + \frac{A_{withinsulation}}{A_{total}} \cdot U_{withinsulation}$$

$$\therefore U_{total} = 25\% \cdot U_{withwood} + 75\% \cdot U_{withinsulation}$$

$$= 25\% \cdot \frac{1}{R'_{withwood}} + 75\% \cdot \frac{1}{R'_{withinsulation}} = 25\% \cdot \frac{1}{1.109\frac{m^2\,℃}{W}} + 75\% \cdot \frac{1}{4.007\frac{m^2\,℃}{W}}$$

$$= 0.4126\frac{W}{m^2\,℃}$$

$$\mathrm{R-value} = \frac{1}{U_{total}} = \frac{1}{0.4126\frac{W}{m^2\,℃}} = 2.4237\frac{m^2\,℃}{w}$$

From the definition of U

$$\dot{Q}_{total} = U_{total} \cdot A_{total} \cdot \Delta T = 0.4126\frac{W}{m^2\,℃} \cdot 50m \cdot 2.5m \cdot 80\% \cdot [22\,℃ - (-2\,℃)]$$

$$= 990.24W$$

QUESTION 2

In 2 pages you shoudl write a summary (in your own word!, in your own words !!) of what you have learnt in this session about radiation and radiative heat transfer

Summary of radiation and radiant heat transfer

Radiant heat transfer and heat transfer are commonly used to describe the scientific waves of electromagnetically induced heat transfer. The intensity and wavelength of the emission depend on the temperature of the luminescent material.

As we have seen, the maximum importance of the application wavelength for heat transfer between 10-7 m and 10-3 m. Heat transfer is transmitted by electromagnetic waves, or photons, which may travel a long distance without interaction for medium. Radiant heat transfer becomes more and more important as temperature rises and may be completely dominant and meeting at a very high level. Thermal radiation is a phenomenon of volume. However, for opaque solids (such as metals), radiation is considered a surface phenomenon because the inner region never reaches the surface.
Blackbody is defined as the ideal emitter and absorber for radiation. Blackbody can be used as a standard for comparable surface radiation characteristics, emitting the largest amount of surface radiation at a given temperature; absorbing all incident radiation regardless of wavelength and direction.

The emitted radiation is a continuous function of wavelength. At any given temperature, it increases with wavelength, peaks, and then decreases with increasing wavelength. At any wavelength, the amount of radiation emitted increases with increasing temperature. As the temperature increases, the curve moves to the left to a shorter wavelength region. Therefore, at higher temperatures, shorter wavelengths will emit a larger proportion of the radiation.