Week 4_WANG YIJIN

Task 1: you should 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

Q:Heat transfer through the simplified wall

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 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 22C and assume 20 percent of the wall area is occupied by glazing.

$R_{UNIT}(\mathrm{m^2{\cdot}℃/w})$	wood	Insulation
Outside air	0.03	0.03
Wood bevel	0.14	0.14
urethane rigid foam insulation	NO	0.98*90/25=3.528
Wood studs(90mm)	0.63	NO
gypsum wallboard	0.079	0.079
wood plywood	0.11	0.11
Inside air	0.12	0.12

$$A = 50 \times 2.5 \times 80\% = 100m^2$$
$$\Delta T = T_1 - T_2 = 22 - (-2) = 24℃$$

$$R'_{\text{with}WOOD} = 0.03 + 0.14 + 0.63 + 0.079 + 0.11 + 0.12 = 1.109\text{m}^2\cdot℃/\text{w}$$

$$R'_{\text{withINS}} = 0.03 + 0.14 + 3.528 + 0.079 + 0.11 + 0.12 = 4.007\text{m}^2\cdot℃/\text{w}$$

$$\because \frac{1}{R_{\text{total}}} = \frac{1}{R_{wood}} + \frac{1}{R_{ins}}, R' = R \times A \to R = \frac{R'}{A}$$

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

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

Both side of the equation divide by A_{tot}

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

$$\because U_{wood} = \frac{1}{R'_{wood}} = \frac{1}{1.109} = 0.902, U_{ins} = \frac{1}{R'_{ins}} = \frac{1}{4.007} = 0.250$$

$$\therefore U_{tot} = 0.25 \times U_{wood} + 0.75 \times U_{ins} = 0.25 \times 0.902 + 0.75 \times 0.250 = 0.413\text{w/m}^2℃$$

$$\text{Q}_{\text{tot}} = U_{tot} \times A_{tot} \times \Delta T = 0.413 \times 100 \times 24 = 991.2W$$

Task 2 In 2 pages you should 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 about radiation and radiative heat transfer

Thermal radiation is the emission of electromagnetic waves from all matter (solids, liquids as well as gases) that has a temperature great than absolute zero. And thermal radiation is one of the three principal mechanisms of heat transfer. Other mechanisms are convection and conduction. Radiation differs from convection and conduction in that it doesn't require the presence of a material medium to take place.

Accelerated charges or changing electric currents give rise to electric and magnetic fields. These rapidly moving fields are called electromagnetic waves or electromagnetic radiation, and they represent the energy emitted by matter as a result of the changes in the electronic configuration of the atom or molecules.

Electromagnetic waves are characterized by their frequency v or wavelength λ, These two properties in a medium are related by

$$\lambda = \frac{\mathrm{c}}{v}$$

$$c = \frac{c_0}{n}$$

c, the speed of propagation of a wave in that medium

$c_0 = 2.9979 \times 10^8 m/s$, the speed of light in a vacuum

n, the index of refraction of that medium

It has proven useful to view electromagnetic radiation as the propagation of a collection of discrete packets of energy called photons or quanta.

Black body

An absolute black body is an object that absorbs at any temperature any wavelength of energy that radiates to its surface.

It is an idealized body to serve as a standard against which the radiative properties of real surfaces may be compared.

A black body emits the maximum amount of radiation by a surface at a given temperature. A black body is a perfect emitter and absorber of radiation.

A black body absorbs all incident radiation, regardless of wavelength and direction.

Black body is a kind of idealized object with the strongest absorption ability to thermal radiation. However, it is possible to design various absolute black bodies in theoretical research.

For example, a hollow container with a wall made of opaque material and a hole in the wall can form a black body.When the ray enters the hole, it will reflect many times in the cavity. Each time, the inner surface of the reflector wall absorbs some energy. If the hole diameter is very small, it is much smaller than the surface area of the container.In this way, the rays can be considered to be absorbed by the hole. A small hole is considered to be an absolute black body.The emissivity of the absolute black body is also 1.

The radiation energy emitted by a blackbody:

$$E_b(T) = \sigma T^4 \qquad (W/\mathrm{m}^2)$$

$$\sigma = 5.670 \times 10^{-8} \qquad W/\mathrm{m}^2 \cdot K^4$$