Q1:

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 rigi foam insulation. 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

Find the two R_{Unit} values, determine the overall unit thermal resistance (the *R*-value) and the overall heat transfer coefficient (the *U*-factor)

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	0.14	0.14
Plywood	0.11	0.11
Urethane Rigi Foam (90mm)	NO	0.98x90/0.25
Wood Stud	0.63	NO
Gypsum Board	0.079	0.079
Inside Surface	0.12	0.12

$$R'_{with\ wood} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 \ = 1.109\ \frac{m^{2\circ}C}{W}$$

$$R'_{with\ insulation} = 0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12 \ = 4.007\ \frac{m^{2\circ}C}{W}$$

$$U_{Wood} = \frac{1}{R'_{with\ wood}} = \frac{1}{1.109} \quad 0.9017\ \frac{W}{m^{2\circ}C}$$

$$U_{Insulation} = \frac{1}{R'_{with\ wood}} = \frac{1}{4.007} \quad 0.2496\ \frac{W}{m^{2\circ}C}$$

$$U_{Total} = U_{Wood} * \frac{A_{Wood}}{A_{Total}} + U_{Insulation} * \frac{A_{Insulation}}{A_{Total}}$$

$$= 25\% \times U_{Wood} + 75\% \times U_{Insulation}$$

$$25\% \times 0.9017 \ + 75\% \times 0.2496 \quad 0.4126\ \frac{W}{m^{2\circ}C}$$

$$\dot{Q}_{Total} = U_{Total} * A_{Total} * \Delta T$$

$$0.4126 \times 50 \times 2.5 \times (1 - 20\%) \times 24^{\circ} C = 990.24\ W$$

Q2: Summary about radiation and radiative heat transfer

radiation:

Both conduction and convection require matter to transfer heat. Radiation is a method of heat transfer that does not rely upon any contact between the heat source and the heated object.
Everything in nature, as long as the temperature is above zero at an absolute temperature (-273.15 degrees Celsius), it is constantly transmitting heat in the form of electromagnetic waves and particles. This way of transmitting energy is called radiation.
For example, we feel heat from the sun even though we are not touching it.

There are three common types of radiation: solar radiation, electromagnetic radiation, and thermal radiation.

Radiation is a form of energy transport consisting of electromagnetic waves traveling at the speed of light. Electromagnetic radiation is related to the frequency of the wave source. When the frequency of the source of the electromagnetic wave is increased so that its wavelength is comparable to the size of the antenna (radiator), the radiant energy increases significantly. The intensity of the radiation is also related to the shape and distribution of the source. The range of the induction field is related to the wavelength λ .The relationship between frequency V and wavelength λ satisfied λ =C/V.

Thermal radiation is a heat transfer method in which an object radiates heat outward in the form of electromagnetic radiation. It does not depend on any external conditions. It is one of the three main ways of conducting heat.

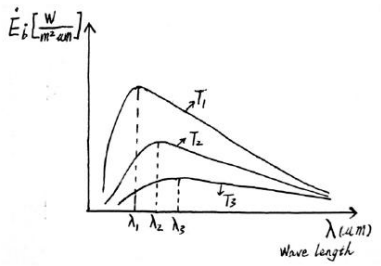
Any object emits radiant energy while absorbing the radiant energy from surrounding objects. The difference between the energy radiated by an object and the energy absorbed is the net energy it transmits. The radiation capacity of an object (that is, the energy radiated outward from a unit surface per unit time) increases rapidly with increasing temperature.
The effect of heat occurs when radiant energy is absorbed by an object. The radiant energy absorbed by the object is different and the temperature produced is different. Therefore, radiation is an important way to convert energy

1.**Kirchoff Law**

$$\tau + \alpha + \rho = 1$$

When α =1， it is called absolute black body
When ρ =1, it is called absolute white body
When τ =1,it is called transparent body

2.**Planck Law**



$T_1>T_2>T_3$
$\lambda_1<\lambda_2<\lambda_3$

Radiative heat transfer:

While the object emits radiant energy outward, it also continuously absorbs the radiant energy emitted by other surrounding objects and converts it into thermal energy. The heat transfer between the objects that emits radiant energy and absorbs radiant energy is called radiative heat transfer. Thermal radiation is a type electromagnetic radiation . Radiation heat transfer is the process by which the thermal energy is exchanged between two surfaces obeying the laws of electromagnetics.Clearly, the net result of radiative heat transfer is that high temperature objects transfer energy to low temperature objects. In addition, radiant energy can be transmitted in a vacuum without any material being used as a medium. Heat rays, like visible rays, obey the laws of reflection and refraction and can travel in a straight line in a uniform medium. Therefore, radiative heat transfer can only be carried out between objects that can be seen each other.