CIV E-1050 Heat and mass transfer in buildings 2021 Autumn Exam

13:00-16:00, Friday, 29.10.2021

This is an open-book exam. Please note that collaboration is prohibited. It's forbidden to post exam questions publicly or share with others. Please provide detailed calculation steps.

1. Descriptive problems

a. What are the major differences between conduction, convention and radiation heat transfer modes? Provide an example to show these three heat transfer modes for the room where you are currently in.

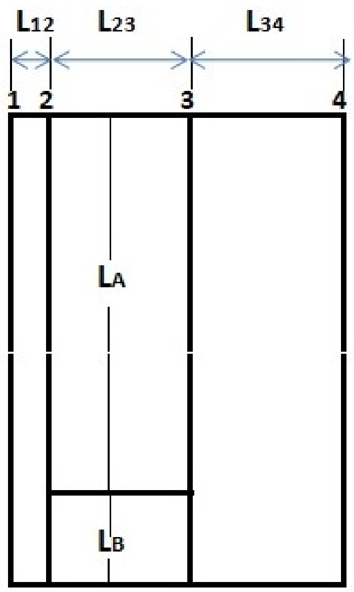
b. In determining convention heat transfer coefficient, why is it important to distinguish hydrodynamic entry and hydrodynamically fully developed regions?

c. For a thick brick wall, describe what could happen to the brick if the driving rain lasts a day?

d. For a wet concrete material, how would you dry the concrete efficiently and effectively?

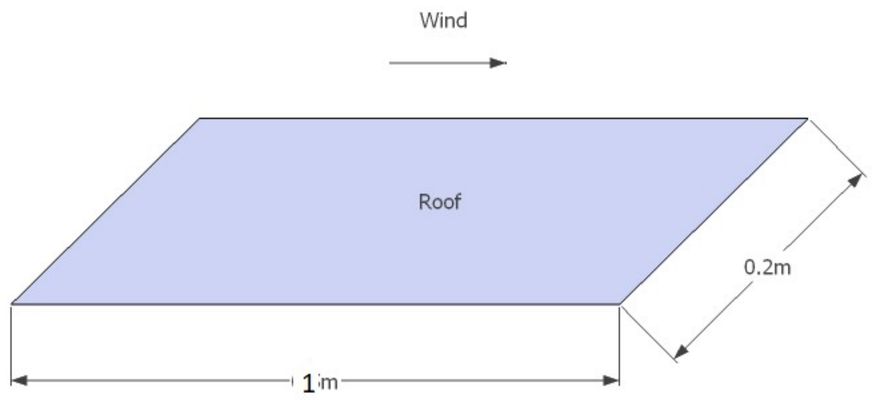
e. Generally which parts of the house are likely to occur moisture problems? Why?

2. Calculate the total thermal resistance of a typical section of a building wall at steady-state condition, assuming that k_{23b} = 100 W/m·K, k_{23a} = 0.06 W/m·K, k_{12} = 1 W/m·K, k_{34} = 2.0 W/m·K, L_A= 0.6m, L_B=0.005m, L_{12}=0.01m, L_{23}=0.08m and L_{34}=0.1m.

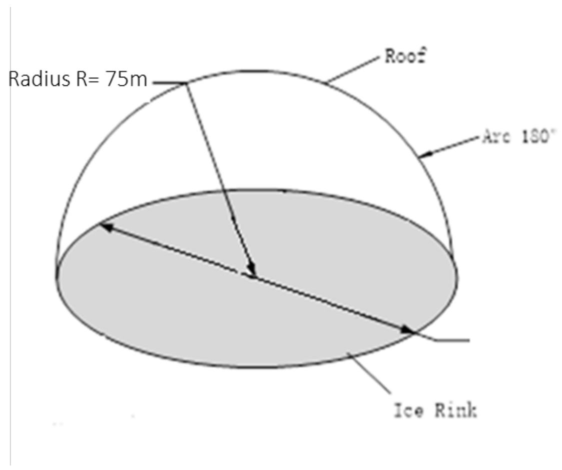


3. Compute the average convention heat loss of the top roof surface with the dimensions of 1 m long and 0.2m width, assuming its surface temperature is 55°C, outdoor air temperature is

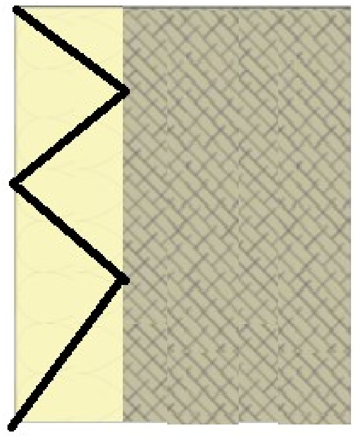
15°C (The average heat transfer coefficient is estimated at the middle edge of the roof (0.5m long))



4. A dome-shaped skating hall is under the design phase. The emissivity of the rink surface is 0.9. Two materials are available for the hemispherical roof with the emissivity coefficients 0.2 and 0.8, respectively. Which material would you select assuming the temperature of the rink surface is fixed -5°C? Justify your answer briefly.

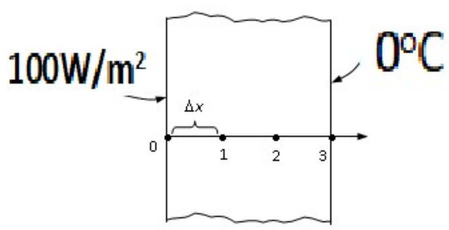


5. Consider a two-layered wall made of 10 cm mineral wool and a 30 cm brick. Estimate if there is a condensation risk. Suggest two ways to prevent the condensation risk in any case.

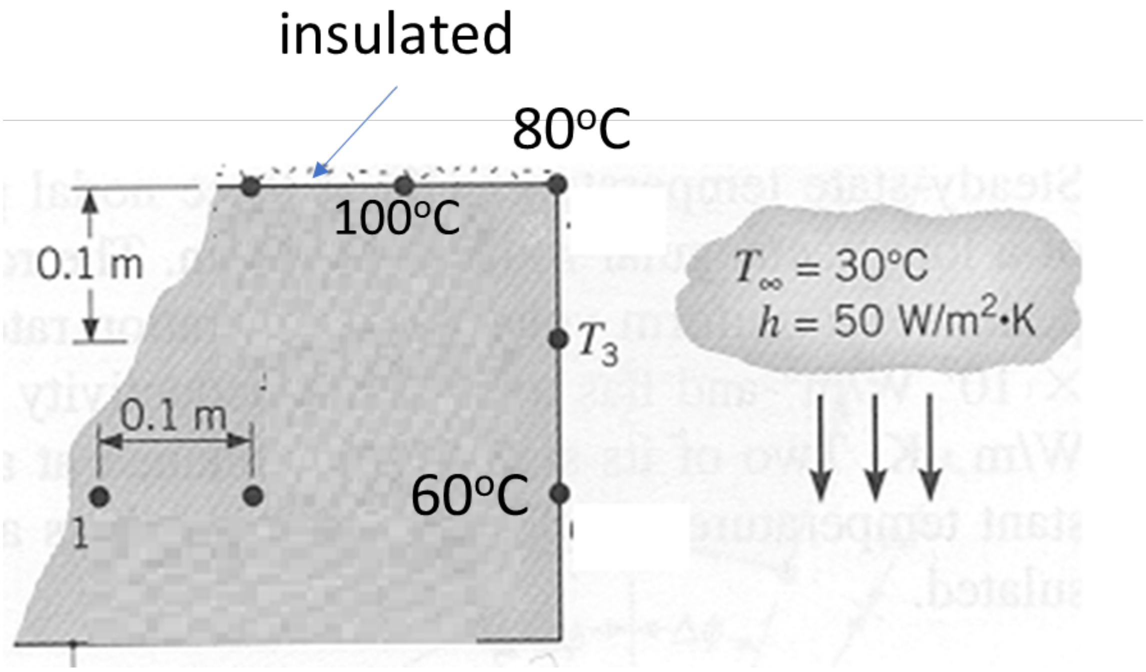


Material	Thermal conductivity K(W/m^{2}k)	vapour resistance R_v 10^{-12} (s.m^2.Pa/kg)	Outdoor	Indoor
Mineral Wool	0.057	0.00022	T=-10°C RH = 90%	T=20°C RH = 70%
Brick	0.577	0.065	h= 25 W/m^{2}K	h= 5 W/m^{2}K

6-a. A wall's surface is heated mildly at the rate of 100W/m^2 under steady state situation. The right surface temperature is 0°C. Assume Δx=0.1 cm, determine the temperatures at nodes 0, 1 and 2 using numerical approach (the wall's conductivity is 0.1 W/m°C).



6-b. Determine the temperature at T3 for the two dimensional plate. The plate's conductivity is 2.0 W/m·°C.



insulated
80°C
100°C
0.1 m
T_3
0.1 m
60°C
1
T_∞ = 30°C
h = 50 W/m^2·K