National Exams December 2012

07-Bld-A5

Building Science

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN BOOK EXAM.
3. Candidates may use one of two calculators, the Casio or Sharp approved models. Write the name and model designation of the calculator, on the first inside left hand sheet, of the exam work book.
4. **FIVE (5)** questions constitute a complete exam paper.
5. The first five questions as they appear in the answer book will be marked.
6. Each question is of equal value.
7. This examination paper includes **Four (4) PAGES and Six (6) QUESTIONS**. You are responsible for ensuring that your copy of the paper is complete. Please bring any discrepancy to the attention of your invigilator.

Problem (1) (20 Points)

Part (A) (10 points)

Discuss wind washing and natural convection within building enclosures. Indicate proper measures needed to control wind-driven convective heat loss from buildings.

Part (B) (10 points)

Calculate air flow rate through 11mm fiberboard insulation under the effect of pressure difference caused by natural convection. The outside temperature is -20 °C, while the inside temperature is 20 °C. The building height is 30 m and the total surface area of the insulating board is 30 m^2. Comment on the adequacy of fiberboard for use as part of an air barrier system.

Problem (2) (20 Points)

Part (A) (5 points)

What is the meaning of RSI-3.5 (R-20)? What is the required thickness of common brick to achieve RSI-3.5 (R-20)?

Part (B) (15 points)

A house has a composite wall made of a 20 mm thick Plywood siding, a 100 mm thick Fiber Glass blanket (k = 0.04 W/m. K), and a 20 mm thick Gypsum Board. The outside and inside air temperatures are -15 °C (258.15 K) and 25 °C (298.15 K), respectively. The total wall surface area is 300 m^2.

i. Determine an expression of the total thermal resistance of the wall, including inside and outside convection effects. Assume typical wind speed.

ii. Determine the total heat loss through the wall.

iii. If wind speed changes from the typical value to 45 mile per hour, determine the percentage increase in the heat loss.

iv. What is the controlling resistance that determines the amount of heat flow through the wall?

Problem (3) (20 Points)

Calculate total irradiation reaching a solar collector installed on a building located in Toronto, Ontario (44° North latitude and 80° West longitude) at 2:00 PM on July 21. The collector is facing East with an angle of tilt equals to 50°.

Problem (4) (20 Points)

Consider a house wall made of a 160 mm thick concrete slab, 80 mm thick type 3 Extruded Polystyrene (EXPS), 30 mm thick airspace, and 90 mm thick face brick. The interior temperature and relative humidity are 23 °C (297.15 K) and 40%. The exterior temperature and relative humidity is -15 °C (258.15 K) and 20%.

i. What is the water vapor pressure at each interface due to vapor pressure diffusion through the wall?

ii. What is the relative humidity at each interface of the assembly?

iii. Would condensation take place within this wall? If it would occur, at which interface?

Problem (5) (20 Points)

Part (A) (5 points)

Discuss the various ways a surface would interact with incident thermal radiation. Indicate the relationship between wavelength and the surface radiation properties.

Part (B) (15 points)

Calculate the mass flow rate of moisture exchanged between a room at 22 °C (295.15 K) and 50% RH and outside air at -5 °C (268.15 K) and 80% RH if 200 CFM of air enters the room. How much sensible and latent heat exchanged as a result of this airflow? Did the space loose or gain these heats?

Problem (6) (20 Points)

Part (A) (5 points): Discuss the "directly controlled" and "incidental implicit" interior environmental conditions within a building.

Part (B) (5 points): Discuss various types of conditioning for buildings.

Part (C) (5 points): Discuss the parameters that affect the indoor environmental quality inside buildings.

Part (D) (5 points): Discuss the means of controlling interior humidity levels in a building.

End