

National Exams December 2014

**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 and so candidates are permitted to make use of any textbooks, references or notes that they wish.
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 and provide full details of the various loadings that affect the performance of building enclosures.

Part (B) (10 points)

- i. Why controlling air flow is important to building performance?
  - ii. What the necessary conditions for air flow to occur in a building?
  - iii. What are the primary mechanisms that generate the pressure difference across the building enclosure?
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**Problem (2) (20 Points)**

Part (A) (8 points)

- i. Discuss the condensation resistance of windows.
- ii. Define the surface temperature index and discuss the criterion for the occurrence of interior surface condensation.

Part (B) (12 points)

A house has a composite wall made of a 20 mm thick Plywood siding, a 100 mm thick Fiber Glass blanket ( $k = 0.04 \text{ W/m.K}$ ), and a 10 mm thick Gypsum Board. The outside and inside air temperatures are  $-15 \text{ }^\circ\text{C}$  ( $258.15 \text{ K}$ ) and  $20 \text{ }^\circ\text{C}$  ( $293.15 \text{ K}$ ), respectively. The total wall surface area is  $300 \text{ m}^2$ .

- i. Determine the total heat loss through the wall.
- ii. Calculate the interface temperature between the Plywood and the Fiber Glass layers.
- iii. Calculate the radiation heat transfer coefficient between the Gypsum board and the house interior. Assume the emissivity of the interior wall finish is 0.75.

**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 45°.

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**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 21 °C (294.15 K) and 50%. The exterior temperature and relative humidity is -14 °C (259.15 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?
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**Problem (5) (20 Points)**

Part (A) (10 points)

- i. Discuss the various criteria of a proper air barrier system.
- ii. Discuss the difference between air barriers and vapour barriers.

Part (B) (10 points)

Calculate the mass flow rate of moisture exchanged between a room at 22 °C (295.15 K) and 55% RH and outside air at -15 °C (268.15 K) and 80% RH if 200 CFM of air leaves the room. How much sensible and latent heat exchanged as a result of this airflow? Did the space lose or gain these heats?

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**Problem (6) (20 Points)**

**Part (A) (10 points)**

- i. What are the conditions required for water to penetrate a building enclosure?
- ii. Discuss the main elements of an effective rain control strategy.

**Part (B) (10 points)**

Discuss water penetration forces in buildings.