National Exams December 2019

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 any non-communicating calculator. 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. Discuss relation between surface temperature and radiation wave length.

ii. What is the wave length range of thermal radiation emitted from surface at normal building temperatures?

iii. What is the temperature of a surface emitting visible light?

Problem (2) (20 Points)

Part (A) (8 points)

i. Discuss air flow model(s) used to analyze air flow through an air space in a wall.

ii. Discuss characteristic on which resistance to air flow in a cavity depends.

Part (B) (12 points)

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

i. Determine the total heat loss through the wall.

ii. Calculate the required thickness of fiber glass insulation in order to reduce total heat loss by 20%.

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 1:00 PM on July 21.

i. The collector is facing East with an angle of tilt equals to 45°.

ii. How would the total irradiation change if the angle of tile is changed to 30 °?

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 80 mm thick face brick. The interior temperature and relative humidity are 21 °C (294.15 K) and 60%. 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?

Problem (5) (20 Points)

Part (A) (10 points)

i. Discuss the various criteria of a proper air barrier system.

ii. Discuss airflow in a tall building due to stack effect.

Part (B) (10 points)

Calculate the mass flow rate of moisture exchanged between a room at 20 °C (295.15 K) and 55% RH and outside air at -10 °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 loose or gain these heats?

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

i. Discuss factors affecting rain deposition rate on a vertical building.

ii. Discuss factors affecting the rain deposition factor.

iii. Discuss coincidence of wind and rainfall.

iv. Discuss enclosure design strategies pertain to rainwater control.

End