Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2022/2023

| | | |
|---|---|---|
| COURSE NAME | : | BUILDING SERVICES |
| COURSE CODE | : | BFB 41003 |
| PROGRAMME CODE | : | BFF |
| EXAMINATION DATE | : | FEBRUARY 2023 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | 1. ANSWER **ALL** QUESTIONS<br>2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**<br>3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION VIA CLOSED BOOK |



THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

**Q1** (a) A good understanding of the heat transfer mechanism in the building is very important to design for thermal comfort. There are three different mechanisms of heat transfer in the building which are conduction, convection and radiation. Explain **THREE (3)** variables that affect heat transfer through radiation compared to other mechanisms.

(6 marks)

(b) JNIL Tower is a 38-storey high-rise office building designed by prominent architects and targeted to achieve Platinum Green Building Rating. As an engineer, you have to propose building envelope materials that can reduce the Overall Thermal Transfer Value (OTTV) of the building while the architectural appearance of the building is not compromised.

(i) Based on the information in **Table Q1**, propose the best OTTV for the building to achieve the OTTV of the Platinum Green Building Rating of 31.4 W/m$^2$.

(13 marks)

(ii) Based on the OTTV calculated in **Q1(b)(i)**, justify **THREE (3)** strategies to get the best Overall Thermal Transfer Value (OTTV) of JNIL Tower.

(6 marks)

**Q2** (a) Evaluate **FOUR (4)** differences between the cooling cycle of the split unit air conditioning system and the chilled water centralised air conditioning system. Draw the cooling cycle of both systems to support your evaluation.

(12 marks)

(b) As an engineer, you were asked to design a suitable duct for air supply in a 15x15x5m high office building. The office is to be ventilated at the rate of 4 air changes per hour. If the airflow rate is limited to 5m/s in the supply duct, determine the following:

(i) the volume flow rate

(1 mark)

(ii) the dimensions of a suitable duct for supplying air.

(3 marks)

(c) The weather in Malaysia is hot and humid year-round. As an engineer, you are appointed to design an air conditioning system suitable for an office building in this climate. Assume that the outside air temperature is 32°C with 65% relative humidity is to be conditioned, so that cold and dry air within the comfort zone in Malaysia can be supplied to the building. By using the psychrometric chart provided, neatly plot the required air conditioning process and estimate the following values:

(i) justify the selected temperature and relative humidity of a comfort zone

(1 mark)

(ii) dew point temperature

(2 marks)

(iii) amount of moisture remove

(2 marks)

(iv) amount of heat remove

(2 marks)

(v) amount of heat added

(2 marks)

**Q3** (a) Based on the combined circuit as shown in **FIGURE Q3** answer the following questions.

(i) Determine the total resistance in the circuit

(4 marks)

(ii) Calculate the total current flow through the circuit

(2 marks)

(iii) Determine the current flow at A and B

(4 marks)

(c) Lifts and escalators are common building transportation systems used in buildings to enable people and goods to move comfortably, quickly, and efficiently. Briefly explain **TWO (2)** purposes of lift traffic analysis.

(4 marks)

(d) Lift traffic performance measurements covered both lift handling capacity and waiting time. The result from lift traffic performance analysis gives an accurate indication of the quality and quantity of lift service provided. Based on the building details as follows:

| | | |
|---|---|---|
| Storey | : | 15 floors |
| Floor to floor height | : | 3.3 meters |
| Net floor area | : | 5940 $m^2$ |
| population density | : | 1 pax/ 30 $m^2$ |

Assume that 15% of the total population are using the lift during 5 min peak time. Based on the information in **Table Q3(i)**, **Table Q3(ii)**, **Table Q3(iii),** and **Table Q3(iv)** estimate the following:

(i) Flow rate

(1 mark)

(ii) Minimum handling capacity, waiting time and number of lifts

(2 marks)

(iii) Travel distance

(2 marks)

(iv) Quality of the lift services in terms of intervals and waiting time.

( 2 Marks)

(c) Briefly discuss what will happen if the total population using the lift during 5 min peak time increases to 30% and what actions should be taken to satisfy the passengers with the lift traffic system.

(3 marks)

**Q4** (a) A new student home accommodation building consisting of six blocks of building needs a suitable water storage tank. Each building has 30 units of houses and each house has 3 rooms. Every room can accommodate a maximum of 3 occupants at one time. Assume head pressure is 8 m and the length of the pipe is 30 m (allow 20% for bends) with negligible head loss. Assume for 24 hours interruption of supplyand a further 12 hours disruption of supply will becovered by 95 litres of cold water per person. Determine the following;

(i) total water requirement for the building.

(2 marks)

(ii) design the suitable shape of water storage tanks to store the water

(6 marks)

(iii) design supply pipes for discharge of 1.30 litres/sec, based on the gravity supply for the building.

(2 marks)

(b) A client requests installing an indoor rainwater harvesting system into a single-story bungalow lin Batu Pahat using gravity fed with the automatic top-up system. Typical features of a single-storey bungalow in Batu Pahat as follows:

- Dual flush toilet
- Assumed water usage 3.5 l/flush, 5 flushes per occupant per day, and 4 occupants in the house
- Metal roof with a total of 100 $m^2$ roof size and less than 40° roof pitch
- Rainfall intensity is assumed to be 150 mm/h
- Rectangular gutter with 1:600 gradient with no bending
- 1.0 mm of rainfall is used as the first flush depth

Based on the information given in **Table Q4(i)** and **Table Q4(ii)**, design a rainwater harvesting system for the house as follows:

(i) Roof catchment runoff

(2 marks)

(ii) Gutter and downsize pipe

(4 marks)

(iii) First flush diverter

(2 marks)

(iv) Water demand and water storage tank

(2 marks)

(v) Top up system

(2 marks)

(c) Water is one of the energies that are important in our lives. Explain **TWO (2)** ways to use water efficiently.

(3 marks)

**– END OF QUESTIONS –**

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**Table Q1**

| Description | West Façade | South Façade | East Façade | North Façade |
|---|---|---|---|---|
| Solar Absorptivity (W/m2.K) of the wall | 0.45 | 0.45 | 0.45 | 0.45 |
| Thermal Transmittance (W/m2.K) of the wall | 2.25 | 2.25 | 2.25 | 2.25 |
| Total area of exterior wall (m2) | 7077 | 6333 | 7077 | 2685 |
| Total area of window (m2) | 3220 | 3829 | 3200 | 2147 |
| Orientation Correction Factor | 0.94 | 0.92 | 1.23 | 0.9 |
| **Glazing materials Specification** | | | | |
| Glass Type | Single Glazing | Laminated Double Glazing | Monolithic Glass | Insulating Glass |
| Thickness | 6.50mm | 8.76mm | 12.00mm | 28.00mm |
| Shading Coefficient | 0.85 | 0.7 | 0.41 | 0.4 |
| Thermal Transmittance (W/m2.K) of the fenestration | 3.1 | 5.1 | 3.8 | 1.3 |
| Colour | Blue | Blue Green | Artic Blue | Blue Green |

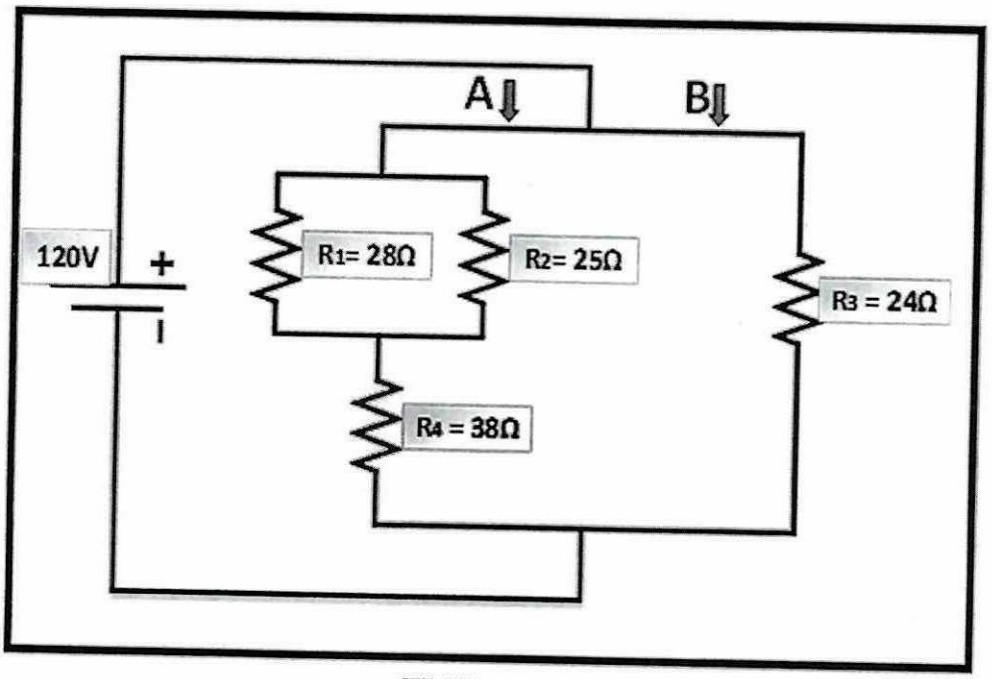


**FIGURE Q3**

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**TABLE Q3 (i)**

| Passenger lift performance (based on 3.3 m floor to floor height) and lifts serving all of 15 floors | | Intervals (s) | | | Handling capacity (persons) |
|---|---|---|---|---|---|
| Number of cars | Speed (m/s) | 12 Passengers | 16 Passengers | 20 Passengers | 24 Passengers |
| | | 29 | 32 | 37 | 41 |
| 4 | 2.50 | 103 | 112 | 127 | 137 |
| | | | 31 | 36 | 40 |
| 4 | 3.50 | | 116 | 132 | 142 |
| | | | 25 | 29 | 32 |
| 5 | 3.50 | | 146 | 165 | 178 |
| | | | | 24 | 27 |
| 6 | 3.50 | | | 198 | 213 |

**TABLE Q3 (ii)**

| Speed (m/s) | Lift travel in metres | | | |
|---|---|---|---|---|
| | Municipal Flats | Luxury flats | Offices | Bed lifts |
| 0.25 – 0.375 | - | - | - | 5 |
| 0.50 | 30 | 15 | 10 | 10 |
| 0.75 | 45 | 20 | 15 | - |
| 1.00 | 55 | 25 | 20 | 20 |
| 1.50 | - | - | 30 | 45 |
| 2.50 | - | - | 45 | 100 |
| 3.50 | - | - | 60 | - |
| 5.00 | - | - | 125 | - |

**TABLE Q3 (iii)**

| Interval (s) | Quality of services |
|---|---|
| 25 – 35 | Excellent |
| 35 – 45 | Acceptable for offices |
| 60 | Acceptable for hotels |
| 90 | Acceptable for flats |

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**TABLE Q3 (iv)**

| Interval (s) | Quality of services |
|---|---|
| 25 – 35 | Excellent |
| 35 – 45 | Acceptable for offices |
| 60 | Acceptable for hotels |
| 90 | Acceptable for flats |

**TABLE Q4 (i)**

| Roof Area (m2) | Roof Runoff Rate (L/s) | Rectangular Eave Gutters (mm) | | | | Rectangular Downpipe* (mm) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cal. Size | | Ava. Size | | Cal. Size | | Ava. Size | |
| | | Width | Depth | Width | Depth | Width | Depth | Width | Depth |
| 50 | 1.98 | 115 | 57.5 | 190 | 150 | 75.9 | 38 | 100 | 50 |
| 60 | 2.38 | 220 | 60 | 190 | 150 | 79.2 | 40 | 100 | 50 |
| 70 | 2.77 | 130 | 65 | 190 | 150 | 85.8 | 43 | 100 | 50 |
| 80 | 3.17 | 135 | 67.5 | 190 | 150 | 89.1 | 45 | 100 | 50 |
| 100 | 3.96 | 150 | 75 | 190 | 150 | 99 | 50 | 100 | 50 |
| 120 | 4.758 | 160 | 80 | 190 | 150 | 105.6 | 53 | 120 | 80 |
| 150 | 5.94 | 175 | 87.5 | 190 | 150 | 115.5 | 58 | 120 | 80 |
| 200 | 7.92 | 195 | 97.5 | 250 | 178 | 128.7 | 64 | 150 | 75 |

**Downsize pipe is 66% of gutter width*

**TABLE Q4 (ii)**

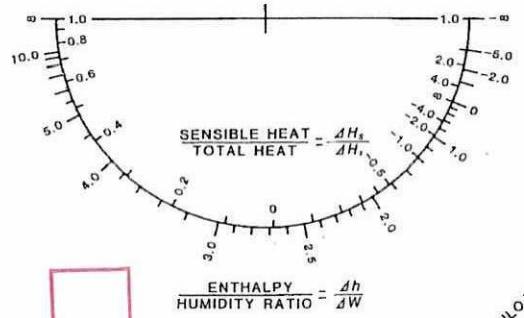
| Demand (liter/day) | Optimum Rainwater Storage Tank Cistern Capacity (m3) Roof Catchment Area (m2) | | | | | |
|---|---|---|---|---|---|---|
| | 50.0 | 100.0 | 200.0 | 300.0 | 400.0 | 500.0 |
| 50 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 100 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 200 | 1.8 | 1.0 | 0.8 | 0.8 | 0.8 | 0.7 |
| 300 | - | 1.9 | 1.3 | 1.3 | 1.3 | 1.3 |
| 400 | - | 3.6 | 2.0 | 1.6 | 1.6 | 1.6 |
| 500 | - | 7.4 | 2.7 | 2.1 | 2.1 | 2.1 |

# ASHRAE PSYCHROMETRIC CHART NO. 1

NORMAL TEMPERATURE SEA LEVEL

BAROMETRIC PRESSURE 101.325 kPa.











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