Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022

COURSE NAME	:	BUILDING SERVICES
COURSE CODE	:	BFB 41003
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2022
DURATION	:	3 HOURS
INSTRUCTION	1.	ANSWER ALL QUESTIONS
	2.	THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **CLOSED BOOK.**
	3.	STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

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Q1 (a) A good understanding of the heat transfer mechanism in the building is very important to design for thermal comfort. As an engineer, you were asked to analyse the heat transfer mechanism of three different types of buildings under renovation which are, a double storey library, a single storey lecture hall, and an eight storey hostel. With the help of a diagram, choose **ONE (1)** type of the building under renovation and explain with a diagram **THREE (3)** different mechanisms of heat transfer in the building

(6 marks)

(b) A green office buildings project will be constructed in Perlis. The project needs to submit an overall thermal transfer value (OTTV) assessment. Based on the information in **Table Q1**, determine the following:

(i) Evaluate the best OTTV for the building in terms of economy and comfort and compared the proposed OTTV to MS1525:2019 Clause 5.2.

(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 a building in the hot climate area.

(6 marks)

Q2 (a) A 10-storey office building that has been built 30 years ago using a split unit air-conditioning system for ventilation and cooling system (HVAC System) in the building. The building owner decided to review the building's HVAC system. Based on the given scenario;

(i) Review **FOUR (4)** problems or benefits related to the split unit air-conditioning system in the building.

(8 marks)

(ii) Propose whether to maintain or change the air conditioning system for the building.

(2 mark)

(iii) State **THREE (3)** justification of your proposed air-conditioning system in question **Q2(a)(ii)**

(6 marks)

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(b) The weather in Malaysia is hot and humid year-round. As an engineer, you are appointed to design an air conditioning system that is suitable for an office building in this climate. Assume that the outside air temperature is 35°C with 70% 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) A combination of parallel and series circuits is shown in **Figure Q3**. The values of **A** and **B** of the two resistors ($\mathbf{R_1}$ and $\mathbf{R_4}$) are the last two digits of your matric number (for example AF2000**AB**). If the digit of your number is zero then take 10. Estimate the equivalent resistance (R_{total}) and current (I) through the circuit.
(8 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 **THREE (3)** purposes of lift traffic control.
(6 marks)

(d) You are appointed as building services engineer to design the lift traffic of an office building that will be constructed in the town of Kuala Lumpur. The details of the building are as follows:

Storey	:	25 floors
Floor to floor height	:	4 meters
Net floor area	:	60,000 m^2
population density	:	1 pax/ 30 m^2

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Assume that 17% 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:

(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)

(v) Briefly discuss what will happen if the total population using the lift during 5 min peak time increases to 35% and suggest what actions should be taken to make the passengers satisfied with the lift traffic system?

(4 marks)

Q4 (a) A 20-story five-star hotel is planning to be constructed in Muar. Each story has 30 units of rooms and each room can accommodate a maximum of 3 occupants at one time. Assume that head pressure is 30 meters, the length of pipe is 120 meters (allow 15% for bends) with the discharge of 1.50 liters/second with negligible head loss. As a consultant engineer, you are required to estimate the total water requirement and design a suitable shape for water storage tanks, suction tanks, and supply pipes for this hotel. Assume for 24 hours of interruption of supply, and further 12 hours of disruption of supply, which will be covered by 95 liters of cold water per person.

(10 marks)

(b) A client requests to install an indoor rainwater harvesting system into a double-story house located in Johor Bahru using gravity fed with the automatic top-up system. Based on the following information and information given in **Table Q4 (i)** and **Table Q4((ii)**, design a rainwater harvesting system for the house.

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Typical features of a double story house in Johor Bahru:

- Dual flush toilet
- Assumed water usage of 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

(12 marks)

(c) As a building services engineer, recommend **TWO (2)** approaches that can be used to encourage Malaysian to implement RWHS in their household.

(3 marks)

– END OF QUESTIONS –

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FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2021/ 2022
COURSE NAME : BUILDING SERVICES
PROGRAMME CODE : 4 BFF
COURSE CODE : BFB 41003

Table Q1

Description	Elevation 1	Elevation 2	Elevation 3	Elevation 4
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
Thermal Transmittance (W/m2.K) of the fenestration	3.1	3.1	3.2	3.3
Total area of exterior wall (m2)	560	560	560	560
Total area of window (m2)	93	68	68	53
Orientation	West	South	East	North
Shading Coefficient of the fenestration				
Single Glazing	0.85			
Low-E Double Glazing	0.31			
Wall Paint Colour Code				
Code 1	Grey			
Code 2	Sky Blue			
Code 3	Lily White			

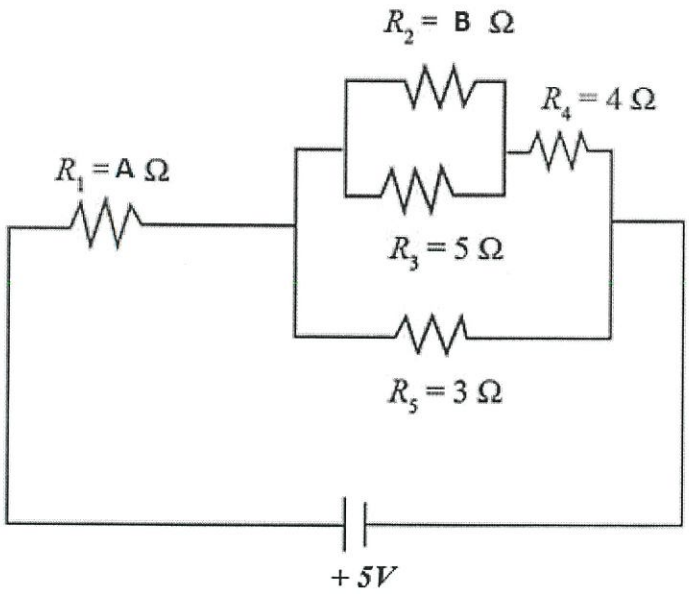

FIGURE Q3

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FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2021/2022
COURSE NAME : BUILDING SERVICES
PROGRAMME CODE : 4 BFF
COURSE CODE : BFB 41003

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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FINAL EXAMINATION

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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 (m^2)	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	120	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	4.75	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

**Downpipe size is 66% of gutter width*

TABLE Q4 (ii)

Demand (liter/day)	Optimum Rainwater Storage Tank Cistern Capacity (m^3) Roof Catchment Area (m^2)					
	50	100	200	300	400	500
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

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