UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	HYDROLOGY
COURSE CODE	:	BFC32002
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE/ JULY 2019
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER: (A) **ONE (1)** QUESTION IN **SECTION A**, AND (B) **ANY THREE (3)** QUESTIONS IN **SECTION B.**

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

SECTION A: ANSWER **ONE (1)** QUESTION

Q1 (a) List **TWO (2)** reasons why groundwater resources are still underutilised in Malaysia.

(4 marks)

(b) Define and sketch confined and unconfined aquifers.

(5 marks)

(c) A confined aquifer has a source of recharge as shown in **FIGURE Q1(c)**. The hydraulic conductivity of the aquifer is 40 m/day and its porosity is 0.2. The piezometric head in two wells 1200 m apart is 50 m and 45 m, respectively, from a common datum. The average thickness of the aquifer is 30 m and the average width is 5 km. Determine the rate of flow through the aquifer.

(6 marks)

(d) A fully penetrating 40 cm diameter well has its bottom 36 m below the static water table. After 24 hours of pumping at 180 m^3/hr, the water level in the pumped well stabilizes to 4 m below the ground level. A draw-down of 0.85 m is noticed in an observation (test) well 120 m away from the pumped well. If the static water table is 1.50 m below the ground level:-

(i) determine the hydraulic conductivity of the aquifer in m/min.

(6 marks)

(ii) sketch the section view and the groundwater profile.

(4 marks)

SECTION B: ANSWER **ANY THREE (3)** QUESTIONS

Q2 (a) Briefly describe **TWO (2)** main differences between the Arithmetic Average and Isohyetal method techniques used to calculate the average watershed precipitation.

(4 marks)

(b) Estimate the constant rate of withdrawal (in m^3/s), from a 1375 ha reservoir in a month of April. The reservoir level dropped by 0.75 m in spite of an average inflow into the reservoir of 50 ha-m/day. During that month the total average infiltration loss from the reservoir was 25 mm, total precipitation was 0.185 m and the total evaporation was 9.5 m.

(5 marks)

(c) **TABLE Q2(c)** shows rainfall data for 2018 at a catchment and the coordinates. Calculate the missing precipitation depth at Station D (0,0) using quadrant method.

(8 marks)

(d) The annual rainfall record for station X and the average annual rainfall for three nearby stations are shown in **TABLE Q2(d)**. Test the uniformity of rainfall records for Station X using double mass curve method and select which year the inconsistency in the data starts.

(8 marks)

Q3 (a) With the aid of sketch, briefly explain the relationship between infiltration capacity and time.

(4 marks)

(b) Distinguish between two different aspects of evapotranspiration namely potential evapotranspiration and actual evapotranspiration.

(5 marks)

(c) In a small catchment, the infiltration rate was observed to be 5.5 cm/h at the beginning of the rain and it decreased exponentially to an equilibrium value of 0.4 cm/h at the end of 9 hours of rain. If k value is 0.3 h^{-1}, calculate:-

i) Infiltration at 3 hours.

(2 marks)

ii) Total infiltration within the first 6 hours.

(3 marks)

iii) Total infiltration between 7 and 9 hours from rainfall begins.

(3 marks)

(d) Rainfall intensity data for seven hours which occurred in 0.2 km^2 catchment area is shown in **TABLE Q3(d)**. The runoff volume generated is 2.8×10^4 m^3. Construct hyetograph and find the Φ index for the catchment.

(8 marks)

Q4 (a) With the aid of sketch, show the paths of surface runoff.

(4 marks)

(b) Explain briefly the river discharge measurement of the stream using the mean section method.

(5 marks)

(c) Calculate cross-sectional area and estimate discharge at the river cross section shown in **FIGURE Q4(c)** using mean section method. **TABLE Q4(c)** provides velocity data for each section.

(8 marks)

(d) Develop a procedure for estimating a peak flow from a single sub-catchment for using the Rational Method.

(8 marks)

Q5 (a) A typical hydrograph is characterized by a rising limb, a crest segment and a recession curve. Discuss each of the characteristic.

(4 marks)

(b) Explain briefly the procedure to derive unit hydrograph

(5 marks)

(c) Streamflows from a catchment area of 20 km^2 due to a storm of 1-hour duration are shown in **TABLE Q5(c)**. Find the unit hydrograph ordinates from an effective rain of 6 cm (UH_{6cm}) and of duration 1 hour. Assume that a constant base flow of 15 m^3/s.

(8 marks)

(d) Using deconvolution method, derive the direct runoff (DRO) from unit hydrograph (UH) given in **TABLE Q5(d)**.

(8 marks)

Q6 (a) Briefly explain one method used for river routing a flood hydrograph. In your explanation, provide the fundamental equation and the assumption of the method.

(4 marks)

(b) Briefly discuss the use of flood routing particularly in the flood mitigation plan.

(5 marks)

(c) The Muskingum routing coefficients for a stream reach are given as $C_0 = 0.4$, $C_1 = 0.5$ and $C_2 = 0.4$. For the given inflow flood hydrograph, apply the Muskingum method to complete the predicted outflow flood hydrograph in **TABLE Q6(c)** at 0500, 1000, 1500, 1800 and 2100 hours.

(8 marks)

(d) Route the inflow hydrograph through a reservoir as indicated in **TABLE Q6(d)**. The crest height of the spillway is 50 ft and storage capacity at this level is 116 ft^3/s-day. The reservoir routing curves graph is given in **FIGURE Q6(d)**.

(8 marks)

– END OF QUESTIONS –

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TABLE Q2(c)

Quadrant	Station	Rainfall depth (mm)	Coordinate	
			X	Y
I	A	80	-2	5
	B	180	-4	1
II	C	125	-5	-3
III	E	122	3	-3
	F	78	2	-6
	G	83	5	-4
IV	H	90	3	4

TABLE Q2(d)

Year	Annual precipitation (cm)			
	A	B	C	X
1979	22	26	23	28
1980	21	26	25	33
1981	27	31	28	38
1982	25	29	29	31
1983	19	22	23	24
1984	24	25	26	28
1985	17	19	20	22
1986	21	22	23	26

TABLE Q3(d)

Time (hr)	0	1	2	3	4	5	6	7
Rainfall intensity, *i* (cm/hr)	0	10	15	13	0	20	10	10

TABLE Q4(c)

Vertical section no.	0	1	2	3	4
Average velocity (m/s)	0	2.1	2.5	2.3	0

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TABLE Q5(c)

Time (hour)	0	1	2	3	4	5	6	7	8	9	10
Stream flow, Q (m^3/s)	15	25	50	55	48	35	30	27	24	20	15

TABLE Q5(d)

Time (hr)	Excess Rainfall (mm)	Direct discharge ($m^3/s.mm$)
1	10	1
2	5	4
3		6
4		20
5		106
6		30
7		14
8		10
9		4
10		2
11		1

TABLE Q6(c)

Time	Inflow (m^3/s)	Outflow (m^3/s)
0000	10	10
0500	40	
1000	110	
1500	80	
1800	35	
2100	24	

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TABLE Q6(d)

Time (day)	Flow (ft^3/s)
0	0
0.5	70
1.0	185
1.5	360
2.0	480

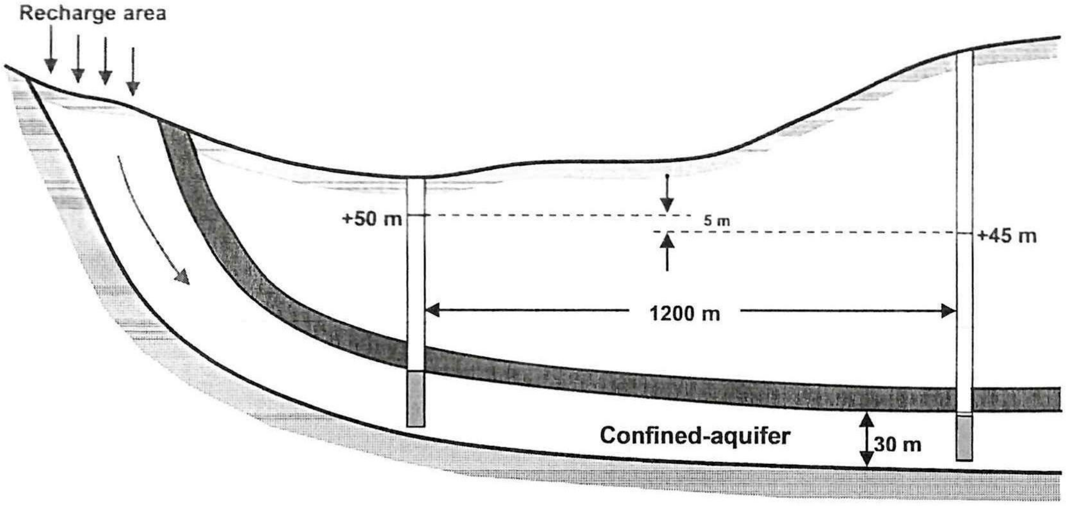

FIGURE Q1(c)

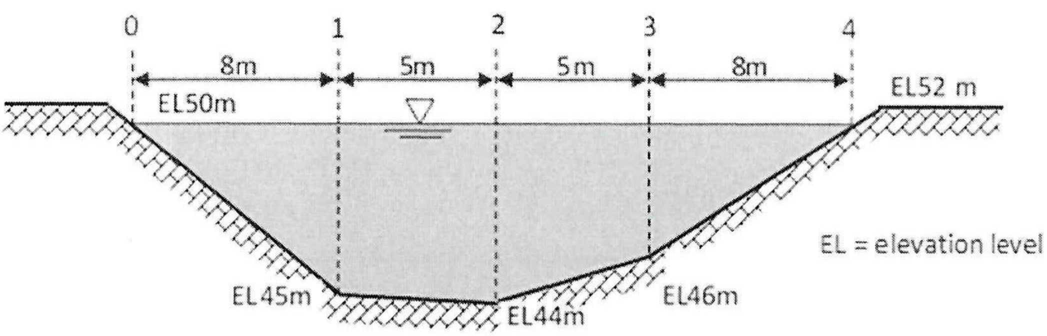

FIGURE Q4(c) River Cross-section

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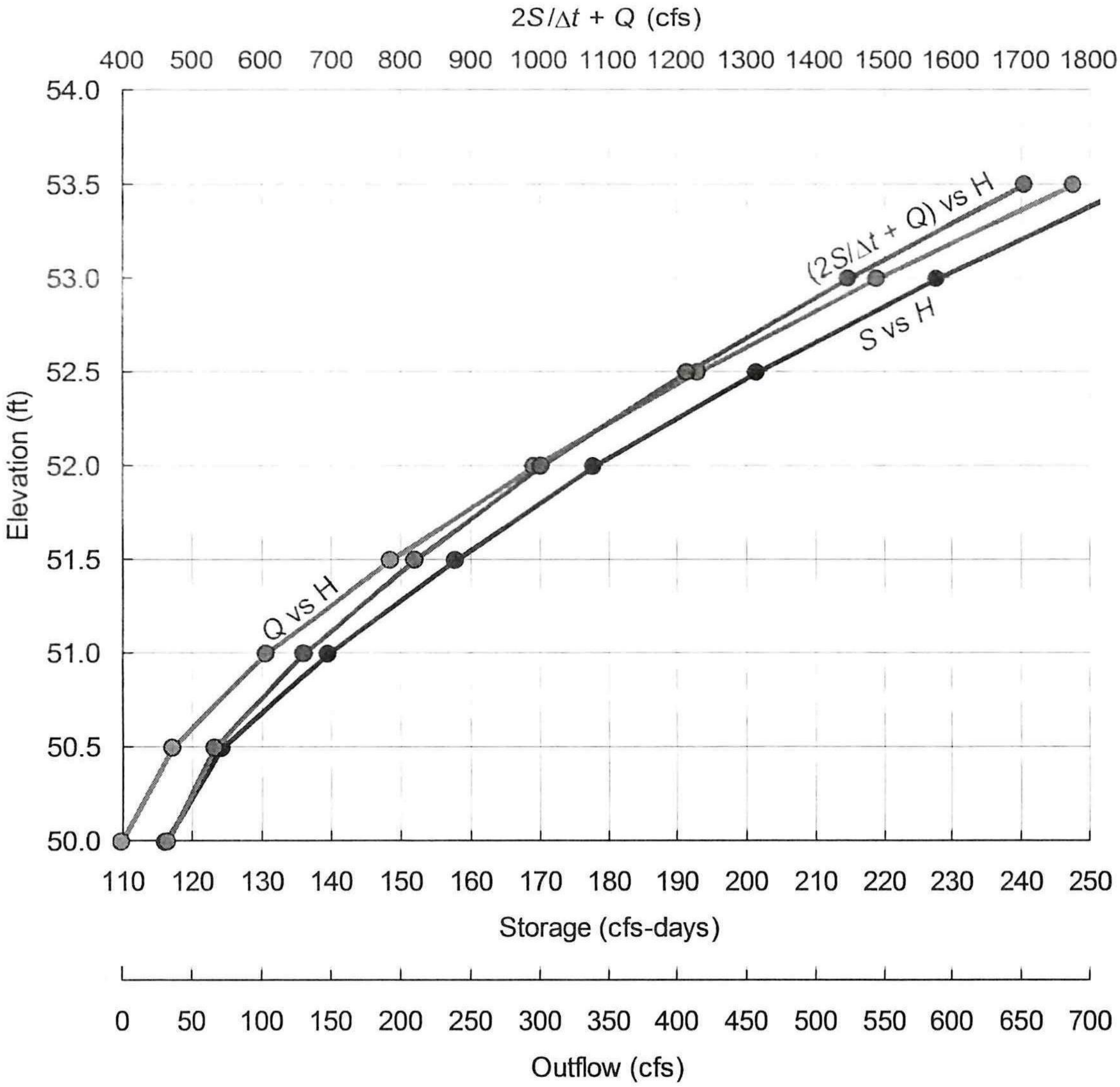

FIGURE Q6(d)

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Equations sheet

$$Q = K A i \qquad H^2 - h^2 = \frac{Q}{\pi K} ln \frac{R}{r}$$

$$I - Q = \frac{dS}{dt} \qquad \text{Index } \phi = \frac{P - R}{t_c} \qquad Q = \frac{C.i.A}{360}$$

$$W_i = \frac{\left(1/L_i^2\right)}{\sum_{i=1}^{n}\left(1/L_i^2\right)} \qquad P_x = \sum W_i \times P_i \qquad Q_n = \sum_{m=1}^{n} P_m U_{n-m+1}$$

$$f = f_c + (f_o - f_c)e^{(-kt)} \qquad F = [f_c t + \frac{(f_o - f_c)}{K}(1 - e^{(-kt)})]_0^t$$

$$O_2 = C_O I_2 + C_1 I_1 + C_2 O_1 \qquad (I_1 + I_2) + \left(\frac{2S_1}{\Delta t} - O_1\right) = \left(\frac{2S_2}{\Delta t} + O_2\right)$$