Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2021/2022

COURSE NAME	:	HYDROLOGY
COURSE CODE	:	BFC 32002
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JANUARY / FEBRUARY 2022
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	1. ANSWER **FOUR (4)** QUESTIONS ONLY. **THREE (3)** QUESTIONS FROM **PART A** AND **ONE (1)** QUESTION FROM **PART B**. 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **CLOSE BOOK**.

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

SECTION A: ANSWER **ALL** QUESTIONS

Q1 (a) Discuss the importance of aquifers in aquatic ecosystem and sketch the comparison between confined and unconfined aquifers.

(5 marks)

(b) **TABLE Q1(b)** shows three layers of soil used in permeability pilot test.

(i) Calculate the average vertical conductivity of the soil in cm/day.

(3 marks)

(ii) Calculate the transmissivity of the soil when water is at the ground surface.

(2 marks)

(iii) Discuss the factors that might affect the results obtained in **Q1(b)(i)** and **Q1(b)(ii)**.

(3 marks)

(c) A pumping well was drilled penetrating straight into an unconfined aquifer with the thickness of 42 m. The distance of pumping well with first extraction well and second extraction well are 20 and 180 m, respectively. Meanwhile, the drawdown for the first extraction well is 4.5 m, and the second extraction well is 1.5 m. The constant pumping rate has been set at 0.09 m^3/s.

(i) Sketch the cross section of unconfined aquifer system and label the values.

(3 marks)

(ii) Determine hydraulic conductivity of the groundwater through the soil media when it was being pumped out and classify the type of soil according to **TABLE Q1(c)**.

(6 marks)

(iii) Point out **THREE (3)** negative effects that might happen for over - pumping aquifers.

(3 marks)

Q2 (a) The value listed in **TABLE Q2(a)** for inflow data was measured at a particular reach of Batu Pahat river. Route the inflow hydrograph through a river reach for $x = 0.1$ and $K = 15$ hours. Assume the river reach length is 2000 m.

(15 marks)

(b) A reservoir has the following elevation, discharge and storage relationship as shown in **TABLE Q2(b)**. Calculate and plot graph of storage routing using modified Puls method (Q vs Elevation and $\left(\frac{2S}{\Delta t} + Q\right)$ vs Elevation). Assume the time intervals Δt is 6 hours.

(10 marks)

Q3 (a) Runoff is the portion of rainfall which flows through rivers or streams. There are several factors that affect the production of runoff such as precipitation characteristic, shape and size of the catchment, topography, meteorological characteristics and others. Choose one factor and discuss it in detail with help of diagram how it affects runoff production.

(6 marks)

(b) Unit hydrographs derivation (UHD) is to develop storm hydrographs due to actual rainfall event over watershed. There are **TWO (2)** methods used to determine UHD, namely convolution and deconvolution method. Describe the differences between these **TWO (2)** methods.

(3 marks)

(c) Determine the unit hydrograph for a basin area of 412.2 km^2 using the rainfall and streamflow data tabulated in **TABLE Q3(c)** and plot the graph.

(16 marks)

SECTION B: ANSWER **ANY ONE (1)** QUESTION

Q4 (a) There are many catchment properties which influence runoff and each may be present to a large or small degree. Identify **FIVE (5)** major catchment characteristics and their effects on runoff.

(5 marks)

(b) Rating curve is a graph drawn connecting the water level elevation of a river channel at a certain cross-section with the corresponding discharge at the section which represents the results of a river discharge measurement. One of the measurements may be made is by velocity-area methods. Demonstrate this measurement method to obtain an estimated reading for the streamflow.

(8 marks)

(c) Sketch and compute streamflow for the measurement data given in **TABLE Q4(c)** using mean-section method. Given that the river width is 12.5 m.

(12 marks)

Q5 (a) **FIGURE Q5(a)** provides an illustration of infiltration capacity curve. Based on your understanding, explain on the φ-index and the use of Horton's model in predicting infiltration capacity.

(5 marks)

(b) Accumulated rainfall on seven (7) successive hours in a catchment were measured as 7, 15, 60, 81.5, 97.6, 120 and 120 cm. If the total runoff at the outlet was 15 cm, quantify the φ-index.

(8 marks)

(c) The annual rainfall record for station X and the average annual rainfall for three (3) nearby stations are shown in **TABLE Q5(c)**. Test the uniformity of rainfall records for station X using double mass curve method, identify which year the inconsistency in the data starts and the correction factor.

(12 marks)

-END OF QUESTIONS-

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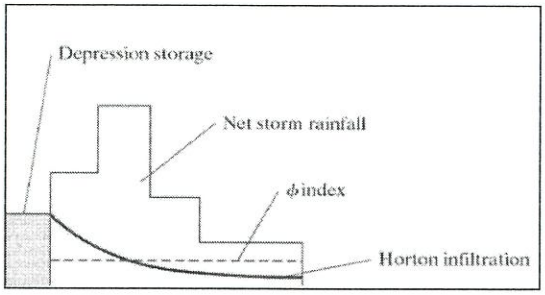

FIGURE Q5(a) Infiltration capacity curve

TABLE Q1(b) Hydraulic conductvity in layers

Layer	Hydraulic conductivity (cm/hour)	Depth (cm)
1	5.5	20.5
2	3	50.2
3	1.0	34.4

TABLE Q1(c) Hydraulic conductivity

Material	Hydraulic conductivity (m/day)
Gravel, coarse	150
Gravel, medium	270
Gravel, fine	450
Sand, coarse	45
Sand, medium	12
Sand, fine	2.5
Silt	0.08
Clay	0.0002
Sandstone, fine-grained	0.2
Sandstone, medium-grained	3.1
Limestone	0.94

TABLE Q2(a) Inflow Data

Time (h)	6	12	18	24	30	36	42	48	54	60
Inflow (m^3/s)	2.83	8.49	19.25	14.16	11.33	8.78	6.51	5.10	2.83	1.42

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TABLE Q2(b) Data for a reservoir

Elevation (m)	Storage (10^6 m^3)	Outflow discharge (m^3/s)
100	3.35	0
100.5	3.47	10
101	3.38	26
101.5	4.38	46
102	4.88	72
102.5	5.37	100
102.75	5.53	116
103	5.86	130

TABLE Q3(c) Inflow Hydrograph

Time (h)	Flow, Q (m^3/s)
0	160
1.5	150
3	350
4.5	800
6	1200
7.5	900
9	750
10.5	550
12	350
13.5	225
15	150
16.5	140

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TABLE Q4(c) Flow Measurement Data

Distance from the edge (m)	Depth (m)	Velocity (m/s)
4.20	0.40	0.00
5.20	0.63	0.00
6.20	0.66	0.03
6.90	0.71	0.08
7.50	0.81	0.13
8.50	0.95	0.40
9.00	0.94	0.85
9.50	0.90	0.54
10.00	0.70	1.43
10.50	0.75	2.04
10.90	0.60	1.87
11.30	0.58	1.63
11.70	0.55	1.50
12.10	0.65	2.52
12.50	0.00	0.00

TABLE Q5(c) Annual Rainfall Data

Year	Annual rainfall (cm)	
	Total	X
2001	71	28
2002	72	33
2003	86	66
2004	83	64
2005	64	90
2006	75	92
2007	56	112
2008	66	118

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Useful Equations

$$\overline{K} = \frac{b}{\left(\frac{b_1}{K_1}\right)+\left(\frac{b_2}{K_2}\right)+\left(\frac{b_3}{K_3}\right)+....\left(\frac{b_n}{K_n}\right)}$$

$$T = \overline{K}b$$

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

$$O_2 = C_O I_2 + C_1 I_1 + C_2 O_1$$

$$C_0 = \frac{0.5\Delta t - Kx}{K(1-x)+0.5\Delta t} \qquad C_1 = \frac{0.5\Delta t + Kx}{K(1-x)+0.5\Delta t} \qquad C_2 = \frac{K(1-x)-0.5\Delta t}{K(1-x)+0.5\Delta t}$$

$$Q = VA \qquad \overline{W}_{N-1} = \frac{\left[W_N + \frac{W_{N-1}}{2}\right]^2}{2W_N}$$

$$\varphi = \frac{P-R}{t_e}$$

$$Correction\ factor = \frac{M_a}{M_o}$$