Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	HYDROLOGY
COURSE CODE	:	BFC 32002
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2021
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	**PART A**: ANSWER **ONE (1)** QUESTION ONLY **PART B:** ANSWER **ALL** QUESTIONS

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

PART A: ANSWER ONE (1) QUESTION ONLY

Q1 (a) A watershed is a contiguous area that intercepts the rainfall and drains to an outlet (stream or ocean). Explain briefly the delineating process of watersheds.

(5 marks)

(b) In April 2020, a 1.37 ha G3 UTHM lake has recorded 0.21 m^3 /s of inflow, 0.13 m^3/s of outflow, and total storage of 0.0223 ha-m. Meanwhile, a rain gauge recorded a total of precipitation depth at 2.5 cm for the lake. With assumption that infiltration loss is insignificant for the lake;

(i) Determine the evaporation loss over the lake for the month, in unit cm.

(4 marks)

(ii) Describe briefly **TWO (2)** types of precipitation

(4 marks)

(c) The consistency of annual precipitation data at rain gauge station in Batu Pahat was measured for 19 years. Rainfall data for Batu Pahat station as well as the annual rainfall measured at a group of eight neighbouring stations located in a region are given in **TABLE Q1(c)**. Calculate in which year change in regime indicated and adjust the recorded data at station Batu Pahat.

(12 marks)

Q2 (a) As a common tropical climate in Malaysia, heat and drought seasons will occur at a certain time, which also carries the heat wave phenomena. During this period, the amount of rainfall events is lesser and the evaporation process will take place at a higher rate than usual. Thus affects the available water storage of main catchment areas. As a knowledgeable hydrologist, this rate of evaporation is driven by several factors. Briefly explain on how the water quality, atmospheric pressure and water depth parameters may affect on the evaporation.

(6 marks)

(b) The infiltration capacity of an area in Universiti Tun Hussein Onn Malaysia at 0.25 hour interval of time are indicated in **TABLE Q2(b).** Formulate an equation for the infiltration capacity in the exponential form.

(12 marks)

(c) Compute the streamflow for the measurement data given in **TABLE Q2(c).**

(7 marks)

PART B: ANSWER ALL QUESTIONS

Q3 (a) Using your own words, discuss the use of S-curve in hydrology and how the analysis is made.

(5 marks)

(b) A stream catchment has a 0.5 hour unit hydrograph (UH) with the ordinates 0, 25, 75, 200, 400, 210, 130, 80, 50, 30, 20, 10 and 0 m^3/s. Convert the following 0.5-hr UH to 3-hr UH.

(8 marks)

(c) Based on 14 days runoff data given in **TABLE Q3(c)**, determine the unit hydrograph for the catchment if the area is 4500 km^2. Separate the baseflow by using appropriate method.

(12 marks)

Q4 (a) Discuss briefly on how to analyze reservoir routing using Puls method.

(5 marks)

(b) Route the inflow hydrograph in **TABLE Q4(b)** through a river reach. Given that Muskingum coefficient K and x are 8 hours and 0.2, respectively.

(i) Calculate the coefficient of C_O, C_1 and C_2 and prove the sum of these coefficients is equal to 1.

(8 marks)

(ii) Determine outflow (m^3/s) and assume the outflow at t = 0 is 8 m^3/s.

(8 marks)

(iii) Plot and label, inflow and outflow in m^3/s in a graph.

(4 marks)

Q5 (a) A confined aquifer has hydraulic conductivity of the aquifer, K =50 m/day and 0.2 of porosity. The piezometric head in two wells are 55 m and 50 m, respectively, which 1000 m apart to each other. The average thickness and width of the aquifer are 25 m and 5 km, respectively. Estimate

(i) The flowrate through the aquifer. Based on the result, describe the type of layer as shown in **TABLE Q5(a)** in terms of storability effect.

(6 marks)

(ii) Time of travel from the head of the aquifer to downstream of 3.5 km by assuming no dispersion or diffusion along the aquifer. Discuss on what would happen if there are dispersion or diffusion occur along the aquifer due to pumping activity

(7 marks)

(b) A 30 cm well fully penetrates an unconfined aquifer of saturated depth 25 cm. When a discharge of 2100 litre per minute was being pumped for a long time, observation wells at radial distances of 30 m and 90 m indicated drawdown of 5 m and 4 m, respectively.

(i) Categorize the coefficient of permeability of the aquifer (Refer **TABLE Q5(b)**).

(4 marks)

(ii) Correlate between the transmissivity values and drawdown at the pumping well. Justify the effect of water drop upon for daily pumping activity.

(8 marks)

– END OF QUESTIONS –

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TABLE Q1(c)

Year	Annual rainfall of Batu Pahat station (mm)	Average Annual rainfall of eight stations (mm)
1991	890	1110
1992	470	680
1993	300	640
1994	420	620
1995	430	770
1996	350	800
1997	330	710
1998	880	730
1999	640	620
2000	720	360
2001	510	690
2002	880	600
2003	590	580
2004	710	470
2005	560	720
2006	770	640
2007	780	660
2008	770	540
2009	790	850

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TABLE Q2(b)

Time (hours)	0	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
Infiltration capacity (cm/hr)	10.4	5.6	3.2	2.1	1.5	1.2	1.1	1.0	1.0

TABLE Q2(c)

Distance (m)	0.0	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6
Depth (m)	0.0	0.3	1.29	2.16	2.55	2.22	1.68	1.41	1.05	0.63	0.42	0.0
Velocity at 0.2 depth (m/s)	0.0	0.42	0.57	0.78	0.87	0.81	0.75	0.69	0.63	0.54	0.45	0.0
Velocity at 0.8 depth (m/s)	0.0	0.21	0.36	0.54	0.60	0.30	0.51	0.45	0.39	0.33	0.30	0.0

TABLE Q3(c)

Time (days)	Runoff (m^3/s)	Time (days)	Runoff (m^3/s)
1	3	8	11
2	3	9	7
3	5	10	4
4	9	11	2
5	15	12	2
6	18	13	1
7	16	14	1

TABLE Q4(b)

Time (hours)	0	4	8	12	16	20	24	28	32
Inflow (m^3/s)	8	16	30	30	25	20	15	12	10

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TABLE Q5(a)

Classification	Hydraulic Conductivity Range (cm/sec)	Condition of Rock Mass Discontinuities
Very Low	$< 1 \times 10^{-5}$	Very tight
Low	$1 \times 10^{-5} - 6 \times 10^{-5}$	Tight
Moderate	$6 \times 10^{-5} - 2 \times 10^{-4}$	Few partly open
Medium	$2 \times 10^{-4} - 6 \times 10^{-4}$	Some open
High	$6 \times 10^{-4} - 1 \times 10^{-3}$	Many open
Very High	$> 1 \times 10^{-3}$	Open closely spaced or voids

TABLE Q5(b)

Materials	Range of K ($m\ day^{-1}$)
Clay soils (surface)	0.2
Deep clay beds	10^{-8}-10^{-3}
Loam soils (surface)	0.1-1
Fine sand	1-5
Medium sand	5-20
Coarse sand	20-100
Gravel	100-1000
Sand and gravel mixes	5-100
Clay, sandand gravel mixes (till)	0.001 - 0.1

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EQUATIONS

$$Q_2 = C_0 I_2 + C_1 I_1 + C_2 Q_1 \qquad (I_1 + I_2) + \left(\frac{2S_1}{\Delta t} - O_1\right) = \left(\frac{2S_2}{\Delta t} + O_2\right)$$

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

$$\text{xI} + (1-x) \qquad S = \rho g b(\alpha + \eta\beta) \qquad S_s = \frac{S}{b} \qquad S_s = \gamma_w[(1-\eta)\alpha + \eta\beta]$$

$$\mathrm{L_e} = \frac{\mathrm{K'}}{\mathrm{b'}} \qquad \mathrm{a} = \frac{\mathrm{K}}{\mathrm{L_e}} \qquad \beta = \sqrt{\frac{\mathrm{Kb}}{\mathrm{L_e}}} \qquad P_x = \tfrac{1}{M}\sum(P_i) \qquad P_x = \sum[W_i P_i]$$

$$t_2 = \frac{L}{C - v_p} \qquad v = \frac{L}{2cos\theta}\left[\frac{1}{t_1} - \frac{1}{t_2}\right] \qquad t_1 = \frac{L}{C + v_p} \qquad Q = K_1\left[\frac{Ed}{l} + K_2\right]$$

$$Q = \frac{(C_1 - C_2)}{(C_2 - C_o)}q \qquad \Delta Q_N = \overline{V_N}\Delta A_N \qquad \Delta A_N = \overline{W_N} y_N \qquad \overline{W_N} = \frac{\left[W_N + \frac{W_{N-1}}{2}\right]^2}{2W_N}$$

$$E = \kappa(e_o - e_a) \qquad E = C(e_o - e_a)\left[1 + \frac{W}{10}\right] \qquad E = (0.013 + 0.00016U_2)e_a\left[\frac{100 - R_h}{100}\right]$$

$$\phi_{index} = \frac{P - R}{t_e} \qquad f = f_c + (f_o - f_c)e^{(-kt)} \qquad F = \left[f_c t + \frac{(f_o - f_c)}{k}\left(1 - e^{(-kt)}\right)\right]_0^t$$

$$P = \frac{P_1 + P_2 + P_3 + \cdots + P_n}{n} = \sum_{i=1}^{n}\frac{P_i}{n} \qquad P_x = \frac{N_x}{M}\sum\frac{P_i}{N_i} \qquad I - Q = \frac{dS}{dt}$$

$$\mathrm{P} = \frac{A_1P_1 + A_2P_2 + A_3P_3 + \cdots + A_nP_n}{A_1 + A_2 + A_3 + \cdots + A_n} = \sum_{i=1}^{n}\frac{A_iP_i}{A} \qquad W_i = \frac{\left[\frac{1}{d_i^{\,2}}\right]}{\sum\left[\frac{1}{d_i^{\,2}}\right]} \qquad P_a = P_o\left[\frac{M_a}{M_o}\right]$$

$$ET_P = \frac{\Delta H + 0.27E_o}{\Delta + 0.27} \qquad E_o = 0.35(e_s - e_a)\,(1 + 0.0098u_2)$$

$$H = R_A(1-r)\left[0.18 + 0.55\frac{n}{D}\right] - B(0.56 - 0.092{e_a}^{0.5})\left(0.10 + 0.9\frac{n}{D}\right)$$

$$H^2 - h^2 = \frac{Q}{\pi K}\ln\left(\frac{R}{r}\right) \qquad H - h = \frac{Q}{2\pi bK}\ln\left(\frac{R}{r}\right) \qquad Q = K\,A\,i$$