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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022

COURSE NAME	:	HYDROLOGY
COURSE CODE	:	BFC 32002
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2022
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	1.	ANSWER ALL QUESTIONS.
	2.	THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **CLOSE 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 **NINE (9)** PAGES

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Q1 (a) With the aid of diagrams, briefly explain **TWO (2)**:

i) Zones that exist in ground water.

(3 marks)

ii) Types of aquifers

(3 marks)

(b) The banks and bottom of a river consist of soil type with leakage coefficient of 0.0099 per day at the average soil depth of 250 cm. The underneath aquifer soil type has an average thickness of 11 m with retardation coefficient of 31460 cm.

(i) Calculate hydraulic conductivity of the banks, bottom and underneath aquifer of the river in m/day.

(2 marks)

(ii) Classify the soil types based on the answers in **Q1(b)(i)** by referring to **Table Q1(b)**.

(2 marks)

(iii) Calculate the leakage factor.

(2 marks)

(c) A fully penetrating of 15-cm diameter well has its bottom 120 meters below the static ground water table. After 24 hours of pumping, the water level in the test well stabilizes to 25 m below the static water table. A draw-down of 6 m is noticed in an observation (test) well 150 m away from the pumped well.

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

(3 marks)

(ii) Following **Table Q1(b)**, examine the type of soil media surrounding this well if the hydraulic conductivity of the groundwater is 1.62×10^{-3} m/s.

(3 marks)

(iii) Analyse the pumping rate that should be set for this well

(7 marks)

Q2 (a) In your opinion, explain the importance of flood routing in terms of design and modelling.

(3 marks)

(b) The surface storage facility controls runoff from a residential area where weir controls the outflow from the basin. The reservoir routing curves are shown in **Figure Q2(b)**.

(i) Analyse the outflow hydrograph from the inflow (refer **Table Q2(b))** using the Puls method.

(17 marks)

(ii) Plot the inflow and outflow hydrographs.

(5 marks)

Q3 (a) Define unit hydrograph (UH) and state **FOUR (4)** applications of UH in engineering hydrology.

(5 marks)

(b) With the aid of diagrams, explain **TWO (2)** techniques of baseflow separation.

(5 marks)

(c) A 6.50×10^8 m^2 natural catchment has characteristics as illustrated in **Figure Q3(c)**. Derive and sketch 2-hour unit hydrograph in graphical view using Soil Conservation Service (SCS) method. Assume that $C_t = 2.2$ and $C_p = 0.7$

(15 marks)

Q4 (a) With the aid of hydrograph, discuss on how urbanization affects the runoff characteristics of a natural and urban catchment.

(5 marks)

(b) Explain the intensity-depth-frequency curve relationship.

(5 marks)

(c) Based on the map in Johor Bahru area shown in **Figure Q4(c)**:

(i) Select any **ONE (1)** of the potential sub-catchments and draft the catchment boundary (Print out or print screen the map and attach in your answer script).

(2 marks)

(ii) Measure the area of the selected sub-catchment using any basic method (show your calculation in the printed map).

(3 marks)

(iii) Identify the peak flow for this catchment area using Rational Method. Assume friction slope of 2%. Refer **Table Q4(c)(i) – Q4(c)(iii)**.

(10 marks)

-END OF QUESTIONS-

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EQUATIONS

$L_e = \frac{K'}{b'}$ $a = \frac{K}{K'/b'}$ $b = \sqrt{\frac{Kb}{K'/b'}}$ $H^2 - h^2 = \frac{Q}{\pi K} ln \frac{R}{r}$

$2S_1/\Delta t - O_1$ $2S_2/\Delta t + O_2$ $t_l = C_t(LL_c)^{0.3}$ $Q_p = \frac{0.208A}{P_r}$

$P_r = \frac{t_r}{2} + t_l$ $Q = \frac{CiA}{360}$ $C_{avg} = \frac{\sum_{j=1}^{m} C_j A_j}{\sum_{j=1}^{m} A_j}$ $i = \frac{\lambda T^{\kappa}}{(d+\theta)^{\eta}}$

TABLES

Table Q1(b): 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

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TABLES

Table Q2(b)

Time (min)	0	15	30	45	60	75	90	105	120	135	150
Inflow (m^3/s)	0	10	25	40	55	50	35	25	15	10	5

Table Q3(c): Table of ratios for the SCS dimensionless unit hydrograph

Time Ratio (*t*/*P*r)	Hydrograph Discharge Ratio (*Q*/*Q*p)	Time Ratio (*t*/*P*r) -continue-	Hydrograph Discharge Ratio (*Q*/*Q*p) -continue-
0	0	1.5	0.66
0.1	0.015	1.6	0.56
0.2	0.075	1.8	0.42
0.3	0.16	2.0	0.32
0.4	0.28	2.2	0.24
0.5	0.43	2.4	0.18
0.6	0.60	2.6	0.13
0.7	0.77	2.8	0.098
0.8	0.89	3.0	0.075
0.9	0.97	3.5	0.036
1.0	1.00	4.0	0.018
1.1	0.98	4.5	0.009
1.2	0.92	5.0	0.004
1.3	0.84	Infinity	0
1.4	0.75		

Table Q4(c)(i): Recommended Runoff Coefficient for Various Land uses

Land use	**Runoff Coefficient (C)**	
	For Minor System (≤ 10 years ARI)	**For Major System (≥ 10 years ARI)**
Residential Area	0.70	0.75
Commercial and Business Centres	0.90	0.95
Sport Fields, Parks and Agriculture	0.30	0.40
Open Spaces – Grass Cover	0.40	0.40
Roads and Highways	0.95	0.95

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TABLES

Table Q4(c)(ii): Equations to estimate time of concentration

Travel Path	Travel Time	Remark
Overland Flow	$t_o = \dfrac{107.n^*.L^{1/3}}{S^{1/5}}$	t_o = Overland sheet flow travel time (minutes) L = Overland sheet flow path length (m) *for Steep Slope (>10%), L ≤ 50 m* *for Moderate Slope (<5%), L ≤ 100 m* *for Mild Slope (<1%), L ≤ 200 m* n^* = Horton's roughness value for the surface (Table 2.2) S = Slope of overland surface (%)
Curb Gutter Flow	$t_g = \dfrac{L}{40\sqrt{S}}$	t_g = Curb gutter flow time (minutes) L = Length of curb gutter flow (m) S = Longitudinal slope of the curb gutter (%)
Drain Flow	$t_d = \dfrac{n.L}{60R^{2/3}S^{1/2}}$	n = Manning's roughness coefficient (Table 2.3) R = Hydraulic radius (m) S = Friction slope (m/m) L = Length of reach (m) t_d = Travel time in the drain (minutes)

Table Q4(c)(iii): Fitting constants for the IDF empirical equation for the different location in Malaysia for high ARIs between 2 and 100 year and storm duration from 5 minutes to 72 hours

State	No	Station ID	Station Name	Constant			
				λ	κ	θ	η
Johor	1	1437116	Stor JPS Johor Bahru	59.972	0.163	0.121	0.793
	2	1534002	Pusat Kem Pekan Nenas	54.265	0.179	0.100	0.756
	3	1541139	Johor Silica	59.060	0.202	0.128	0.660

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FIGURES

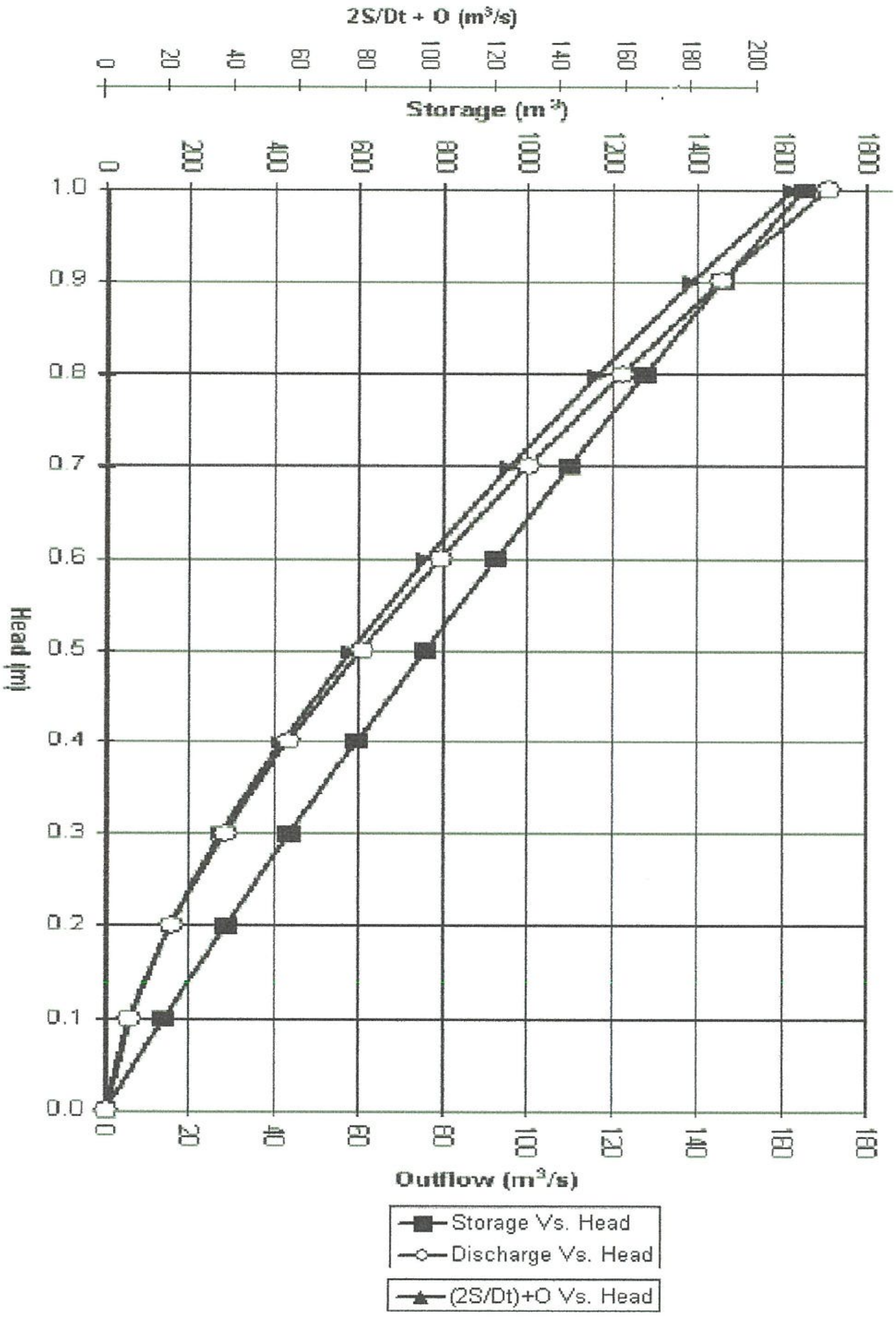

Figure Q2(b) : Reservoir rating curves

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FIGURES

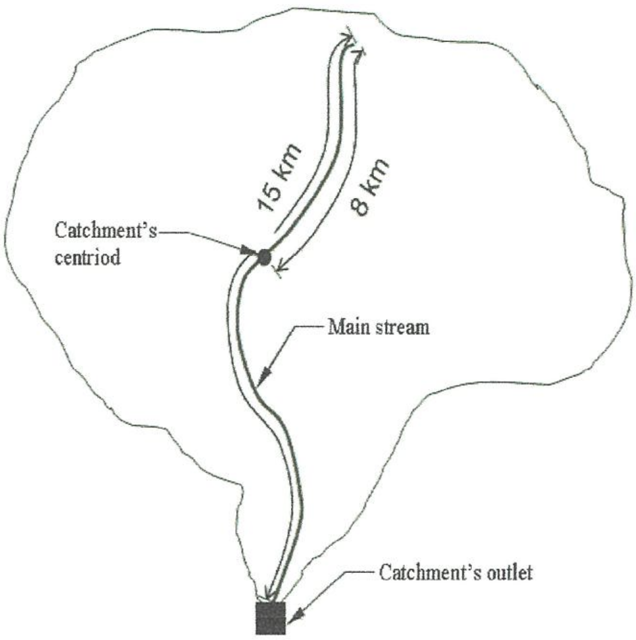

Figure Q3(c): Characteristics catchment for SCS method

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FIGURES

Figure Q4(c): Scale 1 cm : 3.28 km