Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2023/2024

COURSE NAME	:	HYDROLOGY
COURSE CODE	:	BFC 32002
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JANUARY/FEBRUARY 2024
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ 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 **TEN (10)** PAGES

Q1 (a) With the aid of diagrams/equation, briefly explain the followings:

(i) Unconfined aquifer
(ii) Transmissivity
(iii) Hydraulic conductivity

(6 marks)

(b) After a period of pumping at a rate of 150 m^3/hour, the drawdowns in wells 20 m and 35 m from the pumped well were found to be 1.2 m and 0.85 m, respectively. The depth of the pumped well is 20 m below the static water table. Determine

(i) the transmissivity of the aquifer.

(4 marks)

(ii) the hydraulic conductivity of the aquifer.

(2 marks)

(c) A fully penetrating 50 cm diameter main well has its bottom 32.2 m below the static water table. After 24 hours of pumping at 0.15 m^3/s, the water level in the main well stabilizes to 7 m below the static water table. A draw-down of 3.2 m is noticed in an observation well 100 m away from the pumped well.

(i) Calculate the hydraulic conductivity of the aquifer.

(4 marks)

(ii) Sketch the section view of wells and groundwater profile completely.

(4 marks)

(d) As a groundwater engineer, recommend the methods on how to assess the capability of an aquifer, in providing adequate water that meets the water demand.

(5 marks)

Q2 (a) State and sketch **TWO (2)** components of channel storages.

(3 marks)

(b) Briefly describe **ONE (1)** difference between the Muskingum and Puls routing methods.

(3 marks)

(c) The surface storage facility controls runoff from a forest area where weir controls the outflow from the basin. The reservoir routing curves are shown in **Figure Q2.1**. Without any flood event, all the crest height reading, and storage capacity value are at zero reading level.

(i) Analyse the outflow hydrograph from the inflow (refer **Table Q2.1)** using the Puls method.

(14 marks)

(ii) Plot the inflow and outflow hydrographs.

(5 marks)

Q3 (a) Explain the difference between hydrograph and unit hydrograph.

(3 marks)

(b) Daily streamflow for Titiwangsa catchment with an area of 57 ha is shown in **Table Q3.1**.

(i) Plot the hydrograph.

(2 marks)

(ii) By using any **TWO (2)** separation methods, compare the baseflow for this catchment.

(5 marks)

(iii) Compute the UH ordinates using one of the baseflow data from **Q3(b)(ii)**.

(5 marks)

(iv) Plot the UH

(2 marks)

(c) A 86 ha natural catchment having characteristics as illustrated in **Figure Q3.1**. Derive and sketch 4-hour unit hydrograph in graphical view using Soil Conservation Service (SCS) method (**Table Q3.2**). Assume that $C_t = 3.94$ and $C_p = 2.27$

(8 marks)

Q4 (a) With the aid of diagram, define:

(i) catchment boundary,

(2 marks)

(ii) time of concentration t_c for a catchment area.

(2 marks)

(b) (i) Name **ONE (1)** typical method used for peak flow estimation in a catchment area.

(1 marks)

(ii) Following **Q4(b)(i)**, with the aid of graph and equation explain on how to use this method,

(3 marks)

(iii) Discuss the importance of peak flow estimation before the development.

(3 marks)

(c) Based on the map in Jeram Tol Recreation Forest, Jelebu Negeri Sembilan area shown in **Figure Q4.1**:

(i) Select **ONE (1)** of any potential sub-catchments and draw the catchment boundary on the given map.

(2 marks)

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

(3 marks)

(iii) Identify the peak flow for this catchment area using the Rational Method. Refer **Table Q4.1 – Table Q4.2**.

(9 marks)

-END OF QUESTIONS-

APPENDIX A

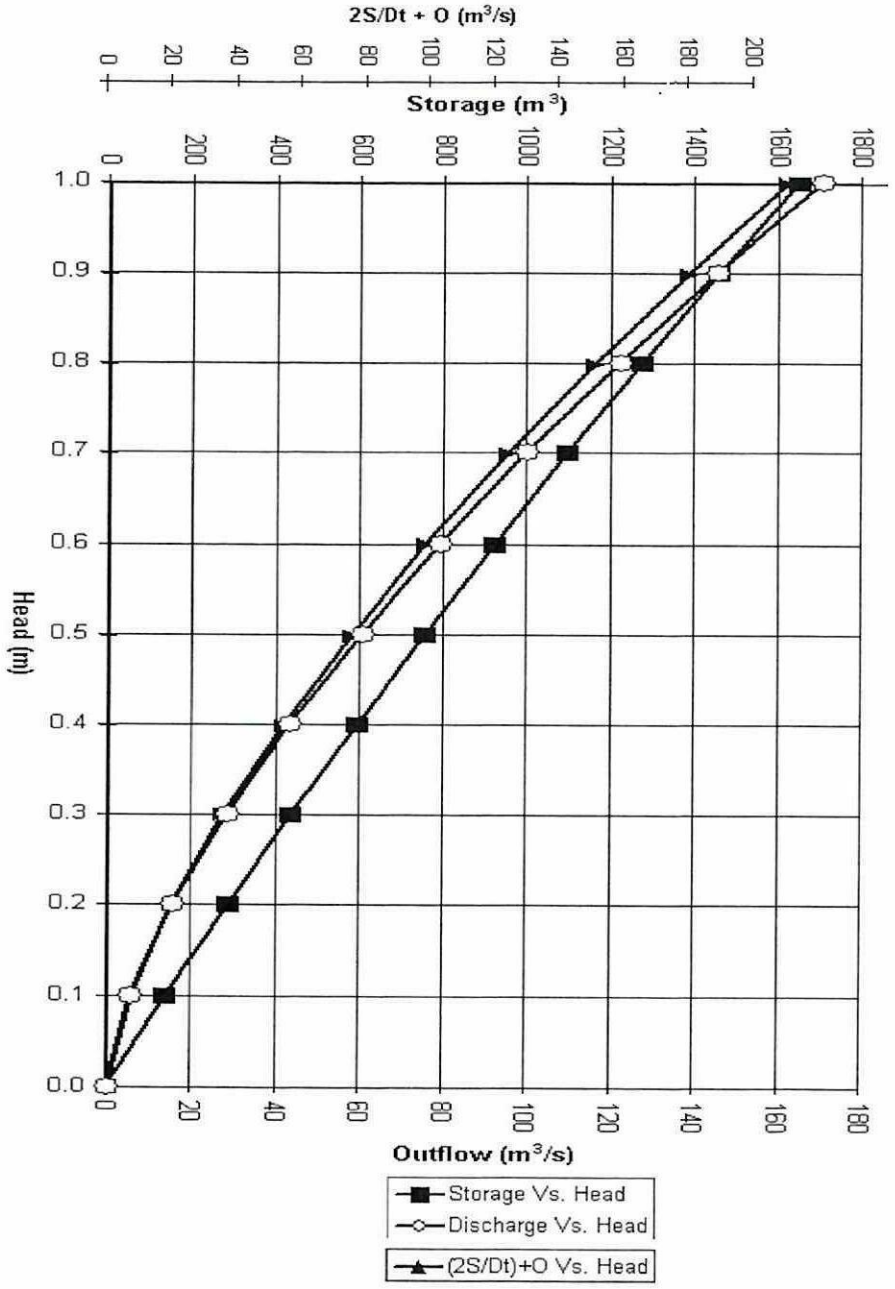

Figure Q2.1 : Reservoir rating curves

APPENDIX B

Table Q2.1 The inflow hydrograph data of the reservoir due to flood event

Time (min)	0	60	120	180	240	300
Inflow (m^3/s)	0	40	105	91	66	45

Table Q3.1

Time (day)	1	2	3	4	5	6
Total flow, Q (m^3/s)	1500	1350	4730	3900	2200	1210

Table Q3.2 Table of ratios for the SCS dimensionless unit hydrograph

Time Ratio (*t*/Pr)	Hydrograph Discharge Ratio (*Q*/*Q*p)	Time Ratio (*t*/Pr)	Hydrograph Discharge Ratio (*Q*/*Q*p)
0	0	2.8	0.098
0.1	0.015	3.0	0.075
0.5	0.43	4.5	0.009
0.8	0.89	5.0	0.004
1.4	0.75	Infinity	0
2.2	0.24		

APPENDIX C

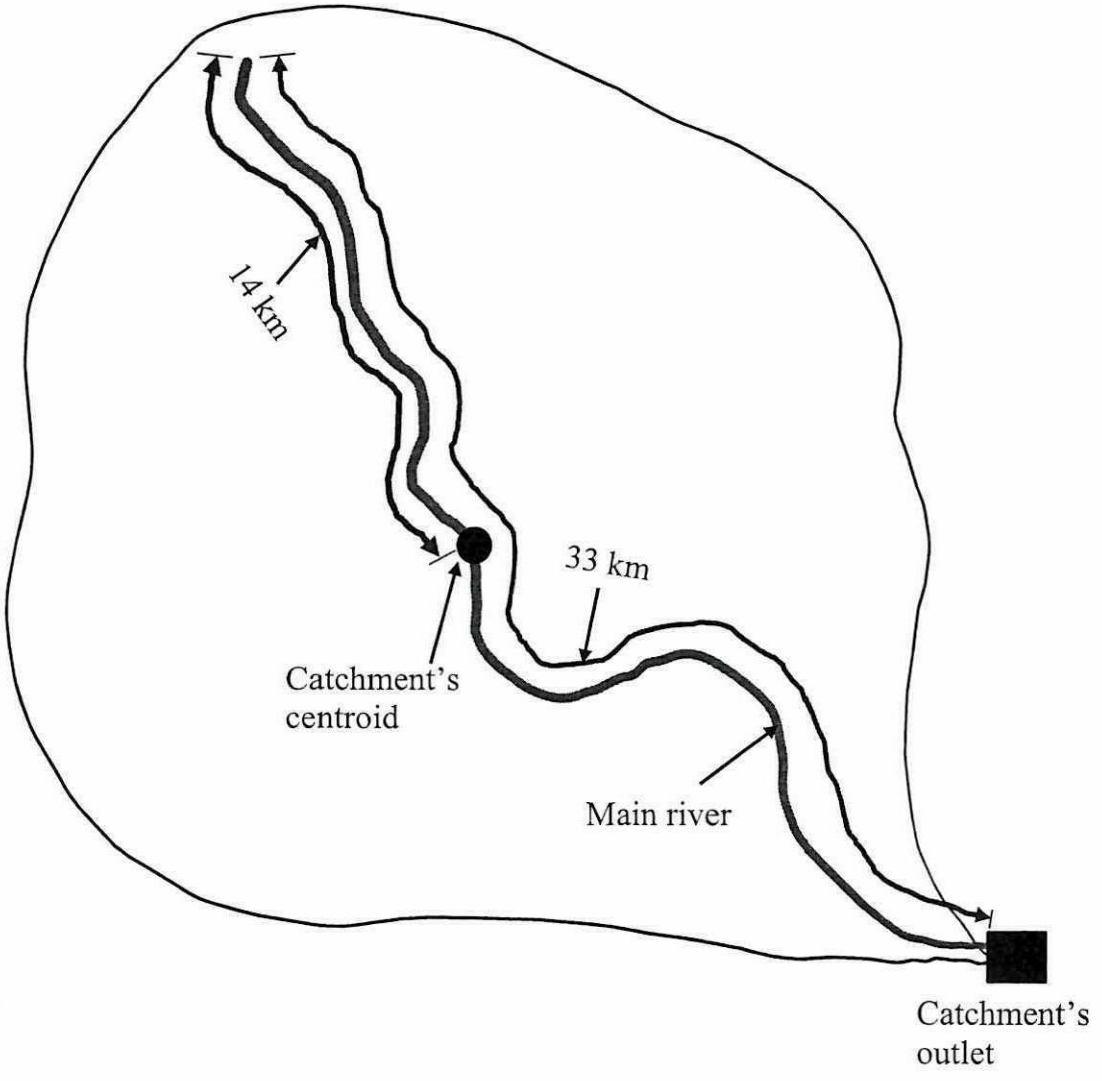

Figure Q3.1 Characteristics catchment for SCS method

APPENDIX D

TEAR THIS PAGE OUT AND ATTACH TOGETHER IN YOUR ANSWER SHEET

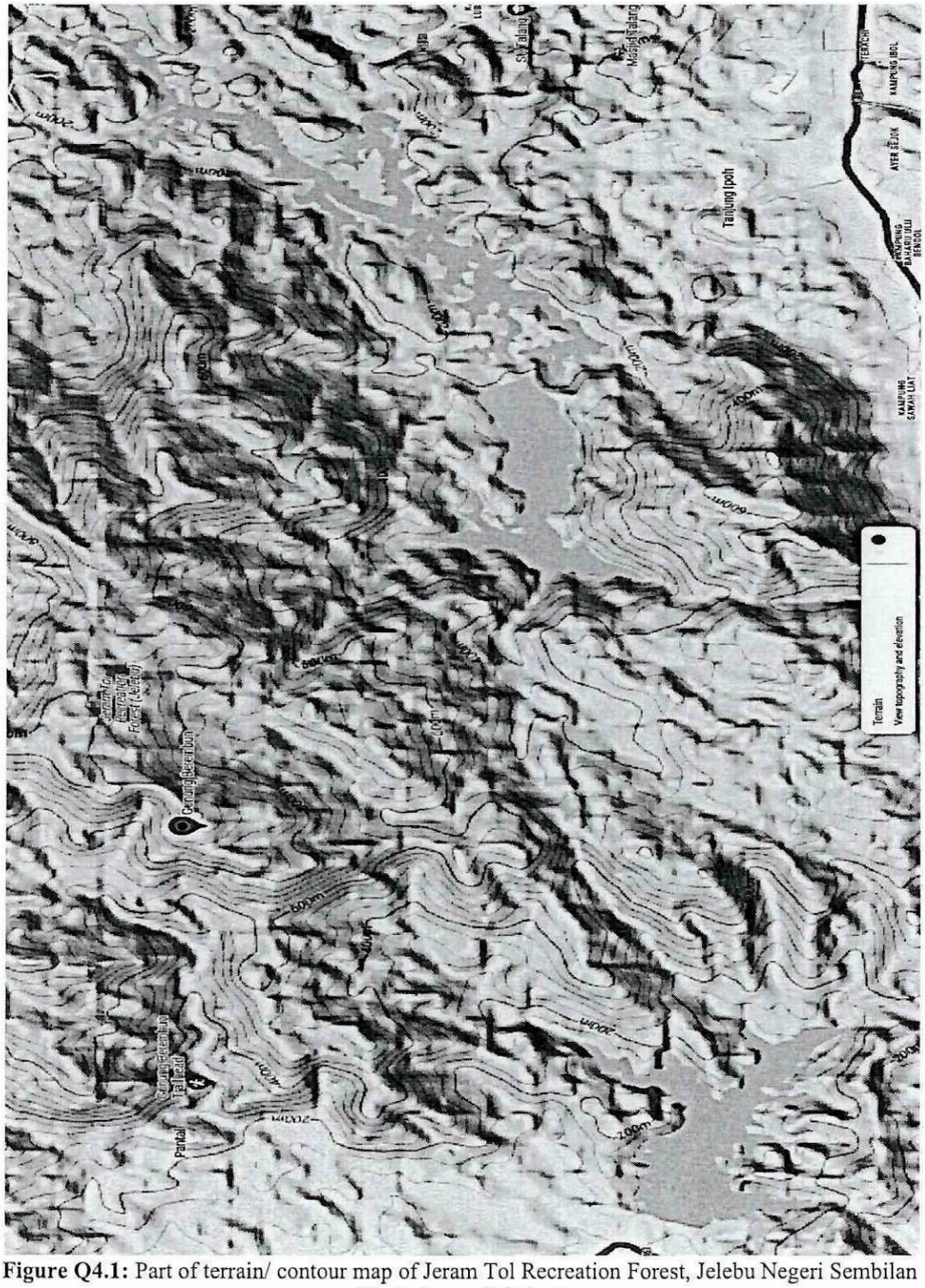

Figure Q4.1: Part of terrain/ contour map of Jeram Tol Recreation Forest, Jelebu Negeri Sembilan (Scale 1 cm : 2.58 km)

APPENDIX E

Table Q4.1 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
Forest	0.60	0.10
Roads and Highways	0.95	0.95

Table Q4.2 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
Negeri Sembilan	1	2719001	Setor JPS Sikamat	60.4227	0.2793	0.2694	0.8540
	2	2722202	Kg Sawah Lebar K Pilah	49.3232	0.2716	0.2164	0.8503
	3	2723003	Sungai Kepis	61.3339	0.2536	0.3291	0.8717
	4	2725083	Ladang New Rompin	65.0249	0.3575	0.3546	0.8750
	5	2920012	Petaling K Kelawang	51.7343	02919	0.2643	0.8630

APPENDIX F: EQUATIONS SHEET

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

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

$$Q_p = \frac{0.208A}{P_r} \qquad t_p = C_t(LL_C)^{0.3} \qquad P_r = \frac{t_r}{2} + t_p$$

$2S_1/\Delta t - O_1$ $\quad 2S_2/\Delta t + O_2$ $\quad Q = \frac{CiA}{360}$

$$C_{avg} = \frac{\sum_{j=1}^{m} C_j A_j}{\sum_{j=1}^{m} A_j} \qquad i = \frac{\lambda T^{\kappa}}{(d+\theta)^{\eta}}$$