Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	HYDRAULICS & HYDROLOGY
COURSE CODE	:	BNP 20103
PROGRAMME CODE	:	BNA/BNB/BNC
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1.ANSWER **ALL** QUESTIONS 2.THIS FINAL EXAMINATION IS CONDUCTED VIA **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 **SEVEN (7)** PAGES

Q1 (a) Water flows in a trapezoidal channel having a side of 1.5(*H*) : 2(*V*), bottom slope So = 0.0007, bottom width, B = 3.5 m and Chezy's C = 73.5. The depth of flow, y is given as 3.2 m. Determine the discharge and mean velocity of the flow.

(8 marks)

(b) A concrete-lined trapezoidal channel with n = 0.015 carrying a discharge of 25.0 m^3/s is to have a longitudinal slope of 0.0008. Analyse the proportions of

(i) an efficient trapezoidal channel section having a side of 1.5(H) : 1(V).

(6 marks)

(ii) the most efficient-channel section of trapezoidal shape.

(6 marks)

Q2 (a) Using a simple sketch, describe the hydraulic jump phenomenon.

(8 marks)

(b) Flow is being conveyed at 10.5 m^3/s in a rectangular channel with a width of 3.2 m, Manning n = 0.015, and a longitudinal slope of 0.0009. Calculate the depth of flow both upstream and downstream of the constriction if the channel width is reduced to 2.8 m.

(12 marks)

Q3 (a) Explain the relationship between head H, efficiency η, inflow power P_i, and the best efficiency point (BEP) of a centrifugal pump.

(4 marks)

(b) A centrifugal pump has an impeller of 300 mm with a capacity of 600 L/s at a speed of 1800 rpm against a head of 15 m. Calculate the speed and head of a geometrically similar pump with an impeller diameter of 300 mm which is required to deliver 700 L/s.

(8 marks)

(c) During the month of November, a 145 hectare lake has 0.54 m^3/s of inflow, 0.38 m^3/s of outflow, and a total storage increase of 2.15 hectare-m. A gauge next to the lake recorded a total of 3.5 cm of precipitation for the lake for the month. Assuming that infiltration loss is insignificant for the lake, determine the evaporation loss, in cm, over the lake for the month.

(8 marks)

Q4 (a) List **FOUR (4)** factors that affect the evaporation process.

(4 marks)

(b) Precipitation gauge X was out of operation for the month of December during which there was a storm. The precipitation amounts at thirteen adjacent stations and the average annual precipitation amounts for the gauges were recorded in **Table Q4(b).** Determine the amount of precipitation for gauge X for the month of December.

(6 marks)

(c) An 8 hours storm has produced rainfall as shown in **Table Q4(c)**. If the excess rainfall is 4 cm, estimate the Φ index.

(10 marks)

Q5 (a) Determine the 4-hour unit hydrograph using the data in **Table Q5(a)** for a watershed having a drainage area of 200 km^2 assuming a constant rainfall loss rate and a constant baseflow of 20 m^3/s.

(8 marks)

(b) The data of the stream measurements and cross section are given in **Table Q5(b)** and **Figure Q5(b)**. Determine the river discharge using the mean section method. The equation of the current meter is $v = 0.65\ N_s + 0.03$.

(12 marks)

- END OF QUESTIONS -

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FIGURE

Figure Q5(b): River Cross-section

TABLE

Table Q4(c): Annual precipitation data

Station	Average annual precipitation (cm)	Amount of precipitation (December) (cm)
A	111.3	10.3
B	93.0	9.5
C	106.4	13.0
D	89.9	8.8
E	108.8	10.1
F	120.3	15.2
X	***96.3***	*?*
H	94.2	9.8
I	90.1	8.0
J	114.3	12.0
K	112.2	10.7
L	118.2	14.6
M	91.3	8.5
N	113.8	10.3

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Table Q4(c): Rainfall data

Time (Hour)	Rainfall (mm)
0.5	2
1.0	4
1.5	8
2.0	1
2.5	0
3.0	3
3.5	10
4.0	13
4.5	11
5.0	5
5.5	1
6.0	0
6.5	2
7.0	3
7.5	2
8.0	1

Table Q5(a): Watershed data

Time (hr)	0	4	8	12	16	20	24	28	32	36	40	44
Flow (m^3/s)	20	25	75	175	225	180	100	80	60	40	25	20

Table Q5(b): Stream measurement data

Vertical section no.	Section Width (m)	Current meter reading			
		0.2d		0.8d	
		Rotation	Time (sec)	Rotation	Time (sec)
0	2.74	0	0	0	0
1	2.74	58	120	45	115
2	274	70	180	60	150
3	2.74	40	115	30	110
4	2.74	0	0	0	0

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FORMULA

Table 1: Open channel flow section geometries

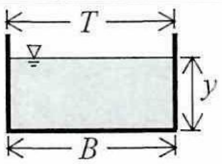
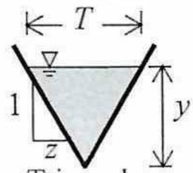
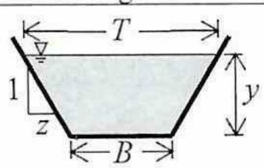
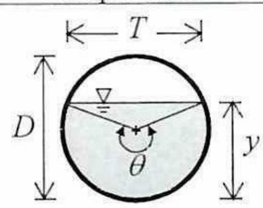
Section	Area A	Top width T	Wetted perimeter P
 Rectangular	By	B	$B+2y$
 Triangular	zy^2	$2zy$	$2y\sqrt{1+z^2}$
 Trapezoidal	$By+zy^2$	$B+2zy$	$B+2y\sqrt{1+z^2}$
 Circular	$\frac{D^2}{8}(\theta-\sin\theta)$	$D\left(\frac{\sin\theta}{2}\right)$	$\frac{\theta D}{2}$

Table 2 : Best hydraulic sections

Cross section	Side slope z	Area A	Wetted perimeter P	Hydraulic radius R	Top width T	Hydraulic depth D	Section factor Z
Trapezoid	$\frac{1}{\sqrt{3}}$	$\sqrt{3}y^2$	$2\sqrt{3}y$	$\frac{y}{2}$	$\frac{4\sqrt{3}}{3}y$	$\frac{3}{4}y$	$\frac{3}{2}y^{2.5}$
Rectangle	-	$2y^2$	$4y$	$\frac{y}{2}$	$2y$	y	$2y^{2.5}$
Triangle	1	y^2	$2\sqrt{2}y$	$\frac{\sqrt{2}y}{4}$	$2y$	$\frac{y}{2}$	$\frac{\sqrt{2}}{2}y^{2.5}$
Semicircle	-	$\frac{\pi}{2}y^2$	πy	$\frac{y}{2}$	$2y$	$\frac{\pi}{4}y$	$\frac{\pi}{4}y^{2.5}$
Parabola	-	$\frac{4\sqrt{2}}{3}y^2$	$\frac{8\sqrt{2}}{3}y$	$\frac{y}{2}$	$2\sqrt{2}y$	$\frac{2}{3}y$	$\frac{8\sqrt{3}}{9}y^{2.5}$

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EQUATIONS

$I - O = \Delta S/\Delta t$ $q = Q/b$ $V = q/y$ $Q = AV$

$$Q = \frac{1}{n} A R^{\frac{2}{3}} S_o^{\frac{1}{2}}$$ $$\frac{N_1 D_1}{\sqrt{H_1}} = \frac{N_2 D_2}{\sqrt{H_2}}$$ $$N_s = \frac{N\sqrt{P}}{H^{\frac{5}{4}}}$$

$$H^2 - h^2 = \frac{Q}{\pi K} \ln\left(\frac{R}{r}\right)$$ $$H - h = \frac{Q}{2\pi b K} \ln\left(\frac{R}{r}\right)$$ $$N_s = \frac{N\sqrt{Q}}{H^{\frac{3}{4}}}$$

$$\frac{Q_1}{N_1 D_1^3} = \frac{Q_2}{N_2 D_2^3}$$ $$E = y + \frac{Q^2}{2gA^2}$$ $$\frac{P_1}{N_1^3 D_1^5} = \frac{P_2}{N_2^3 D_2^5}$$

$$E_L = \frac{(y_2 - y_1)^3}{4 y_1 y_2}$$ $$A = \left(2\sqrt{1+z^2} - z\right) y_e^2$$

$$B = \sum\left(\frac{tp}{100}\right)$$ $$P_{cx} = P_x \frac{M_c}{M_o}$$

$$\frac{y_2}{y_1} = \frac{1}{2}\left[\left(\sqrt{1 + 8 Fr_1^{\,2}}\right) - 1\right]$$

$$U = K_s B$$ $$\mathrm{Fr} = \frac{V}{\sqrt{gD}}$$

$$q = y_o \frac{1}{n} R^{\frac{2}{3}} S_o^{\frac{1}{2}}$$

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