UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	HYDRAULICS & HYDROLOGY
COURSE CODE	:	BNP 20103
PROGRAMME CODE	:	BNA/BNB/BNC
EXAMINATION DATE	:	JUNE / JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **ALL** QUESTIONS ONLY

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

Q1 (a) Define
(i) Uniform flow
(ii) Non-uniform flow

(4 marks)

(b) Open channel flow is flow of a liquid in a conduit with a free surface subjected to atmospheric pressure such as canals and flumes. Explain what are canals and flumes.

(6 marks)

(c) Calculate the top surface width *T*, flow area A, wetted perimeter *P*, hydraulic radius *R* and velocity, *V* based on the triangular channel that carries a discharge of 5.46 m^3/s as shown in **Figure Q1(c)**.

(5 marks)

(d) The **Figure Q1(d)** shows a trapezoidal channel made of concrete lining with longitudinal length $L = 40$ m. Estimate the total cost to construct the channel if the excavation cost = RM 4/m^3 and lining cost = RM 6/m^2.

(10 marks)

Q2 (a) A 2 m width of rectangular channel is conveying flow at 240 m^3/min. Manning *n* and slope of channel is given as 0.05 and 0.00937, respectively. At the middle of the channel,

(i) Determine the normal and critical depth of flow.

(3 marks)

(ii) Analyse depth of flow before and after the constriction width and sketch the flow surface profile

(6 marks)

(b) Francis turbine is a reaction type hydraulic turbine to convert hydraulic energy into mechanical and electrical energy. It is allowed water to be pumped by the centrifugal pump from the reservoir into the turbine casing and spins the turbine as well as direct current (DC) generator motor. This will generate power and displayed as voltage and current. **Table Q2 (b)** shows the data generated from the Francis turbine system with varied load combinations. From the data given, calculate:
i) Power generated (W)

ii) Turbine input power (W)
iii) Turbine efficiency (%)

(8 marks)

(c) From the calculated data, plot a graph for the turbine efficiency versus turbine speed.

(4 marks)

(d) Give **TWO (2)** examples of applications on Francis turbine in engineering field.

(4 marks)

Q3 (a) State **TWO (2)** the importances of hydrology in water resources development.

(4 marks)

(b) With the aid of sketch, explain the hydrological cycle.

(6 marks)

(c) The inflows and outflows in a reservoir are given in **Table Q3(b)** for the first three months of the year. If the storage at the beginning of January is $60m^3$, determine the storage at the end of March.

(5 marks)

(d) An amount of 8.5 cm of water evaporated from a 250 hectare reservoir during two days. Storm water was added to the reservoir at a constant rate of 7.5 m^3/s during this period. Compute the volume of water released during the period if the water level in the reservoir was the same at the beginning and at the end of the day. Give answer in hectare-cm. (1ha = 10000 m^2)

(10 marks)

Q4 (a) Define evaporation and transpiration.

(4 marks)

(b) Describe briefly

(i) Index Φ

(2 marks)

(ii) Horton infiltration model.

(3 marks)

(c) Rain gauge X was out of operation for a month during which there was a storm. The rainfall amounts at three adjacent stations A, B, and C were 17.3 cm, 10.1 cm and 12.0 cm, respectively. The average annual precipitation amounts for the gauges are $X = 97.6$, $A = 100.3$, $B = 88.0$ and $C = 106.4$ cm. Calculate the amount of rainfall for gauge X.

(6 marks)

(d) Estimate the missing precipitation depth (cm) using the quadrant method for the data tabulated in **Table Q4(d).**

(10 marks)

- END OF QUESTIONS –

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FIGURES

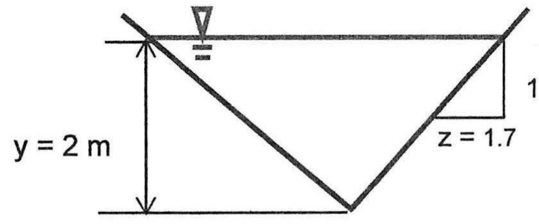

Figure Q1(c) Cross section of triangular channel

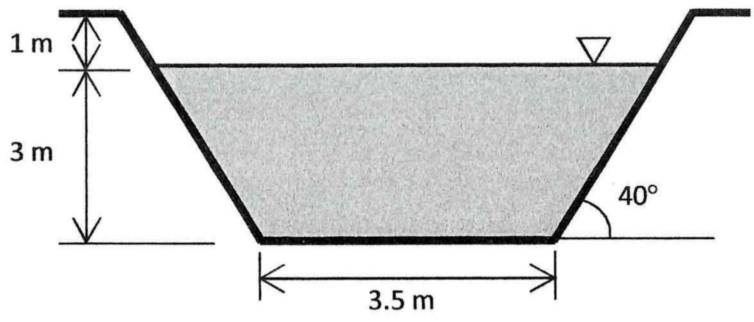

Figure Q1(d) Cross section of trapezoidal channel

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TABLES

Table Q2 (b) Data generated from the Francis turbine system

Local Combinations	-	L1	L2	L3	L4	L5
Turbine Pressure, PT	atm	2.02	1.96	1.38	1.22	1.10
Water Flowrate	liter/sec	4.99	5.03	5.19	5.68	5.82
Turbine Speed	rpm	2129	2039	1157	775	341
Turbine Voltage	V	99.1	94.2	48.7	29.5	8.1
Turbine Current	A	0.24	0.47	2.7	3.48	4.24
Power Generated	W					
Input Turbine Power	W					
Efficiency	%					

Table Q3(b) Inflow and outflow data

Month	Jan	Feb	Mar
Inflow (m^3)	6	8	15
Outflow(m^3)	3	4	9

Table Q4 (d) Precipitation Data

Quadrant	Gauge	Precipitation Depth (cm)	Coordinates (x,y)
I	A	15.7	6,15
	B	13.1	14,8
II	C	6.5	7,-8
	D	13.1	14,-8
IV	E	16.5	-9,10
	F	11.3	-18,7
	G	7.7	-15,19

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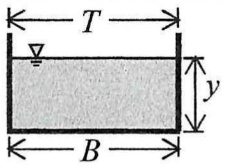
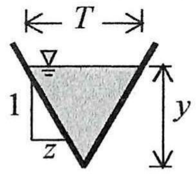
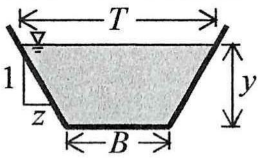
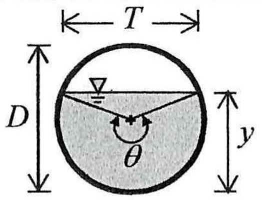
EQUATIONS

Table: 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	$\frac{D^2}{8}(\theta-\sin\theta)$	$D\left(\frac{\sin\theta}{2}\right)$	$\frac{\theta D}{2}$

$$I - O = \Delta S/\Delta t \qquad P_X = 1/M \quad \Sigma(P_i)$$

$$P_X = N_X/M\ \Sigma(P_i/N_i) \qquad W_i = \frac{\left(1/L_i^{2}\right)}{\sum_{i=1}^{n}\left(1/L_i^{2}\right)} \qquad L_i^2 = X^2 + Y^2$$

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

$$N_s = \frac{N\sqrt{Q}}{H^{\frac{3}{4}}}$$

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$$\frac{N_1 D_1}{\sqrt{H_1}} = \frac{N_2 D_2}{\sqrt{H_2}} \qquad \frac{Q_1}{N_1 D_1^3} = \frac{Q_2}{N_2 D_2^3} \qquad \frac{P_1}{N_1^3 D_1^5} = \frac{P_2}{N_2^3 D_2^5}$$

$$Q = \frac{1}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}} \qquad E = y + \frac{q^2}{2gy^2}$$

1. Power Generated (W)

   $P_{gen} = I \times V$

2. Turbine Input Power (W)

   $P_{input} = P_{gage} \cdot Q$

   $= (PT - 1) \cdot Q$

3. 1 atm l/s = 101.325 W

4. Turbine Efficiency (%)

   $$Efficiency = \frac{P_{gen}}{P_{input}} X\ 100$$