Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	HYDRAULICS AND HYDROLOGY
COURSE CODE	:	BNP 20103
PROGRAMME	:	2 BNA/BNB/BNC
EXAMINATION DATE	:	DECEMBER 2014/JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS. **TWO (2)** FROM PART A AND **TWO (2)** FROM PART B. **ONE (1)** FROM ANY PARTS

THIS QUESTION PAPER CONSISTS OF TEN (10) PAGES

PART A: HYDROLOGY

Q1 (a) Define the following:
(i) Precipitation
(ii) Infiltration

(3 marks)

(b) In April 2014, a 10 km^2 lake has 1.2 m^3/s of average inflow from a river and 1.1m^3/s of outflow from the lake via another river. 90 mm of the lake evaporation was observed and the water level increase of 100 mm was recorded during that month. Determine the precipitation (in mm) for the lake in that month.

(5 marks)

(c) Given are two sets of data for one area with 500 km^2 using two different methods. **Table Q1(i)** given by Thiessen polygon method while **Table Q1(ii)** by isohyetal method were used for estimating average rainfall for a water catchment.

(i) Estimate the average rainfall for the catchment area using both methods.

(10 marks)

(ii) Based on the approaches of these two methods, justify which method would give more accurate result over another one method.

(2 marks)

Q2 (a) Sketch the general input and output system of a catchment area.

(2 marks)

(b) With the aid of graph, describe the characteristic of typical hydrograph that consists of rising limb, crest segment and recession curve.

(4 marks)

(c) List all parameters or components in hydrograph analysis. Discuss on **TWO (2)** main factors that affect the shape of hydrograph.

(5 marks)

(d) The mean section method was implemented to measure river discharge and the value was found to be 25 m^3/s. The data of the measurements is listed in **Table Q2** and **Figure 2**. Determine river width if stream channel cross section is equally divided into the same segment sizes. The equation of the current meter is $v = 0.65\ N_s + 0.03$.

(9 marks)

Q3 (a) Explain briefly the following processes:

(i) Evaporation
(ii) Transpiration
(iii) Evapotranspiration

(6 marks)

(b) An isolated storm in a catchment produced a runoff of 3.5 cm. The mass curve of the average rainfall depth over the catchment is shown in Table Q3. Calculate:

(i) The Φ index for the storm;
(ii) Rainfall excess; and
(iii) Sketch the circumstances in form of hyetograph.

(14 marks)

PART B: HYDRAULICS

Q4 (a) Flow inside an open channel is divided into two namely uniform and non-uniform flows. State **TWO (2)** types of non-uniform flows.

(3 marks)

(b) Water flows with normal depth y_0 at 5.1 m in a rectangular channel lining with concrete (n = 0.023). The channel has 19 m bottom width and bottom slope 0.0048. Calculate the velocity and discharge of this channel.

(5 marks)

(c) A rectangular channel is designed for best hydraulic channel section to flow a 19.8 m^3/s water. This channel has to be lined using rubble pitching stones (n = 0.017) with bed slope S_o is 0.0005. Calculate the normal depth y_0, using graphical method, and bed width B of channel. (Refer to **Table Q4**)

(12 marks)

Q5 (a) Define the following:

(i) Specific energy
(ii) Alternate depths

(5 marks)

(b) A prismatic rectangular channel 2 m width with Manning roughness coefficient n = 0.02 carries water at a steady rate of 12 $m^3/s/m$ on a slope S_0 at 0.001. Calculate;

(i) Normal water depth, y_0
(ii) Critical depth, y_c

(5 mark)

(c) A hydraulic jump occurs in a horizontal rectangular channel. If Froude number before the jump, Fr_1 is 12.0 m and energy loss, E_L is 4.2 m, estimate:

(i) sequence depths, y_1 and y_2
(ii) height of jump,
(iii) discharge per meter width,
(iv) power dissipated per meter width

(10 marks)

Q6 (a) Name **THREE (3)** types of pumps and **THREE (3)** types of turbines and briefly describes the function of pumps and turbines.

(6 marks)

(b) Using the aid of sketches, explain the concept of series and parallel pump.

(5 marks)

(c) A centrifugal pump discharges 0.02 m^3/s against a head of 16 m when the speed is 1500 rpm. The diameter of the impeller is 0.4 m and the brake power is 5 kW. A geometrically similar pump 0.45 m in diameter is to run at 1750 rpm. Assuming equal efficiencies, calculate

(i) The head developed.
(ii) The amount of water pumped
(iii) The brake power developed.

(9 marks)

- END OF QUESTION –

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TABLE Q1(i)

Station	Area (km^2)	Precipitation Depth (cm)
A	145	4
B	45	8
C	245	10
D	65	6

TABLE Q1(ii)

Mean precipitation from isohyetal interval (cm)	Area (km^2)
4.5	60
5.5	125
6.5	70
7.5	65
8.5	90
9.5	70
10.5	20

TABLE Q2

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

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TABLE Q3: CUMULATIVE RAINFALL

Time (hour)	0	1	2	3	4	5	6
Accumulated Average Rainfall (cm/h)	0	0.5	1.65	3.55	5.65	6.80	7.75

TABLE Q4: BEST HYDRAULIC SECTIONS

Cross section	Area A	Wetted perimeter P	Hydraulic radius R	Top width T	Hydraulic depth D	Section factor Z
Trapezoid	$\sqrt{3}y^2$	$2\sqrt{3}y$	$\frac{y}{2}$	$\frac{4\sqrt{3}}{3}y$	$\frac{3}{4}y$	$\frac{3}{2}y^{2.5}$
Rectangle	$2y^2$	$4y$	$\frac{y}{2}$	$2y$	y	$2y^{2.5}$
Triangle	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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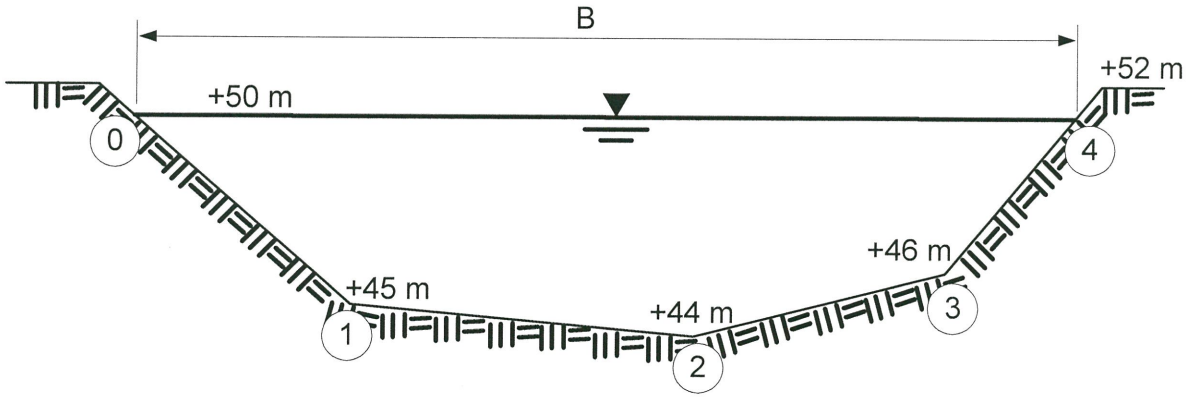

FIGURE Q2

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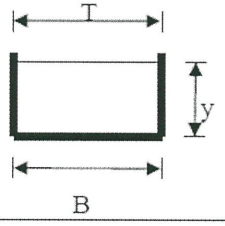
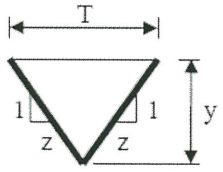
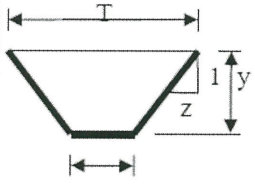
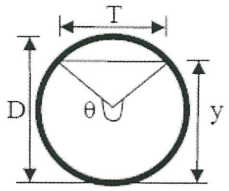
GEOMATRIC ELEMENT TABLE

Bentuk	A	T	P
	By	B	B + 2y
	zy^2	2zy	$2y\sqrt{1+z^2}$
	$By + zy^2$	B + 2zy	$B + 2y\sqrt{1+z^2}$
	$\frac{D^2}{8}(\theta - \sin\theta)$ θ dalam radian	$D(\sin\frac{\theta}{2})$ atau $2\sqrt{y(D-y)}$	$\frac{\theta D}{2}$ θ dalam radian

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EQUATIONS

$$A = \frac{D^2}{8}(\theta - \sin\theta) \qquad P = r\theta \qquad T = 2\sqrt{y(D-y)} \qquad Fr = \frac{v}{\sqrt{gD}}$$

$$Q = \frac{1}{n}AR^{2/3}\sqrt{S_o} \qquad \frac{y_2}{y_1} = \frac{1}{2}\left(-1+\sqrt{1+8Fr_1^2}\right) \qquad E_0 = y_0 + \frac{V^2}{2g}$$

$$q = \frac{1}{n}y_0 R^{\frac{2}{3}} S_0^{\frac{1}{2}} \qquad y_c = \left(\frac{q^2}{g}\right)^{\frac{1}{3}} \qquad E_{\min} = 1.5y_c \qquad i = \frac{n^2v^2}{R^{4/3}}$$

$$h_l = \frac{(y_2 - y_1)^3}{4y_1y_2} \qquad P_l = \rho g Q E_l \qquad \Delta z_{\min} = E_0 - E_{\min}$$

$$dx = \frac{\left(y_2 + \left(\frac{v_2^2}{2g}\right)\right) - \left(y_1 + \left(\frac{v_1^2}{2g}\right)\right)}{S_o - S_{ave}} \qquad F_{r1} = \frac{V}{\sqrt{gy_1}} \qquad dx = \frac{dy}{S_o}\left[\frac{1-\left(\frac{y_c}{y_{ave}}\right)^3}{1-\left(\frac{y_o}{y_{ave}}\right)^{10/3}}\right]$$

$$Q = \frac{2}{3}C_d\sqrt{2g}LH_1^{3/2} \qquad C_d = 0.611 + 0.075\left(\frac{H_1}{P}\right) \qquad K = \frac{1}{n}AR^{2/3}$$

$$Q = \frac{8}{15}C_d\sqrt{2g}\tan\theta\, H_1^{5/2} \qquad Q = \frac{2}{3}C_d B\sqrt{2g}\, L_e H_1^{3/2} \qquad Q = baC_d\sqrt{2g(y_0 - y_1}$$

$$L_e = L - (0.1nH_1)$$

$$\left(\frac{H}{N^2D^2}\right)_M = \left(\frac{H}{N^2D^2}\right)_P \qquad \left(\frac{Q}{ND^3}\right)_M = \left(\frac{Q}{ND^3}\right)_P \qquad \left(\frac{P}{N^3D^5}\right)_M = \left(\frac{P}{N^3D^5}\right)_P$$