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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2013/2014

COURSE NAME	:	HYDRAULICS AND HYDROLOGY
COURSE CODE	:	BNP 20103
PROGRAMME	:	2 BNB
EXAMINATION DATE	:	DECEMBER 2013/JANUARY 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **TWO (2)** QUESTIONS FROM PART A AND **TWO (2)** QUESTIONS FROM PART B

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

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PART A - HYDRAULICS

Q1 (a) Define the following terms:-

(i) Hydraulic radius
(ii) Hydraulic depth
(iii) Uniform flow
(iv) Non-uniform flow
(v) Sewerage.

(5 marks)

(b) Water flows uniformly at a depth of 1.35 m inside a circular cement channel with diameter of 2.42 m as shown in **Figure Q1**. If the channel has Manning's coefficient n of 0.012 and channel slope of 0.06°, calculate :-

(i) Flow rate, Q
(ii) Froude number and define the flow condition.

(10 marks)

(c) Determine the velocity and flow rate in a trapezoidal section with the gradient 0.005 and 1.5 m depth. Given 'Kutter' coefficient, n is 0.015.

$$\text{Given : } C = \frac{23 + \dfrac{0.00155}{S_o} + \dfrac{1}{n}}{1 + \dfrac{n}{\sqrt{R}}\left[23 + \dfrac{0.00155}{S_o}\right]}$$

(10 marks)

Q2 (a) Define hydraulic jump.

(2 marks)

(b) A prismatic rectangular channel 2 m width carries water at a steady rate of 12 m^3/s/m on a slope S_0 = 0.001 with Manning roughness coefficient n = 0.02. Broad-crested weir is constructed in the channel to control flow, find the minimum height of the weir, Δz.

(8 marks)

(c) A rectangular channel of width 7.2 m flows discharge at 20.53 m^3/s with a depth of 0.56 m. If the hydraulic jump occurred within the channel, determine the followings:-

(i) Depth after the jump
(ii) Height of jump
(iii) Type of jump
(iv) Energy loss
(v) Power loss.

(15 marks)

Q3 (a) Explain briefly :-

(i) Pelton turbine

(ii) Propeller pump

(4 marks)

(b) Briefly discuss on cavitation process occurrence in a pump.

(6 marks)

(c) A model study of a centrifugal pump gave the following characteristics :-

$N = 1200$ rev/min
$Q = 0.91\ m^3/min$
$H = 47$ m
$e = 85$ %.

The diameter of the impeller was 50 cm. If a similar prototype of a diameter 0.8 m is to be designed, calculate :-

(i) The operational speed to deliver a flow of 0.1 m^3/s

(ii) Attainable head at the above flow rate

(iii) The power required to run the pump.

(15 marks)

PART B

Q4 (a) Explain briefly on water balance equation.

(5 marks)

(b) Gauge *X* was installed in January 1958 and removed from its original location in January 1962.

(i) Adjust the record as in **Table Q4** for the period from 1958 to 1962 using the records at gauges *P, Q* and *R*.

(12 marks)

(ii) Plot cumulative precipitation for station *X* versus cumulative precipitation of base stations.

(8 marks)

Table Q4

Year	Annual rainfall (cm)			
	P	*Q*	*R*	*X*
1958	54	50	56	50
1959	60	60	66	58
1960	64	58	70	60
1961	68	66	74	62
1962	58	58	60	52
1963	56	52	54	60
1964	64	68	68	72
1965	70	68	72	76
1966	62	58	68	72
1967	56	54	58	62

Q5 (a) List **TWO (2)** factors which affect infiltration process.

(2 marks)

(b) Monthly precipitation (mm) observed at gauging stations in catchment A is shown in **Table Q5**(b). Determine the average areal precipitation using isohyetal method.

(5 marks)

Table Q5(b)

Isohyetal interval	Average precipitation (mm)	Area (km^2)
<102	102	1
102 - 112	107	3
112 – 120	116	4
120 - 122	121	3
>122	122	2

(c) An isolated storm produced surface runoff volume of 17500 m^3 over 50 hectares catchment area. The cumulative rainfall over the catchment is shown in **Table Q5(c)**.

(i) Sketch and label the hyetograph.

(10 marks)

(ii) Calculate the Φ index for the storm in cm/hr.

(8 marks)

Table Q5(c)

Time (minute)	Cumulative rainfall (cm)
0	0
30	0.5
60	1.65
90	3.55
120	3.55
150	4.70
180	6.80
210	7.95
240	8.45

Q6 (a) State **THREE (3)** applications of Unit Hydrograph (UH) in engineering hydrology.

(3 marks)

(b) With the aid of schematic diagram, differentiate between mid section method and mean-section method in measuring the discharge of the stream.

(7 marks)

(c) A 6.50×10^8 m^2 natural catchment having characteristics as illustrated in **Figure Q6**.

(i) Derive the 2-hour unit hydrograph using Soil Conservation Service (SCS) method. Assume that $C_t = 2.2$ and $C_p = 0.7$

(10 marks)

(ii) Show the unit hydograph graphically.

(5 marks)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I/ SESSI 2013/2014 PROGRAMME : 2 BNB
COURSE NAME : HYDRAULICS AND HYDROLOGY COURSE CODE : BNP 20103

FIGURE

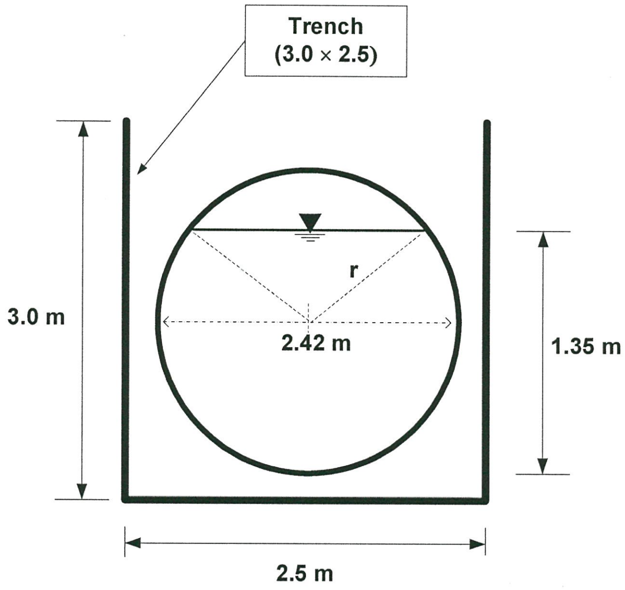


Figure Q1

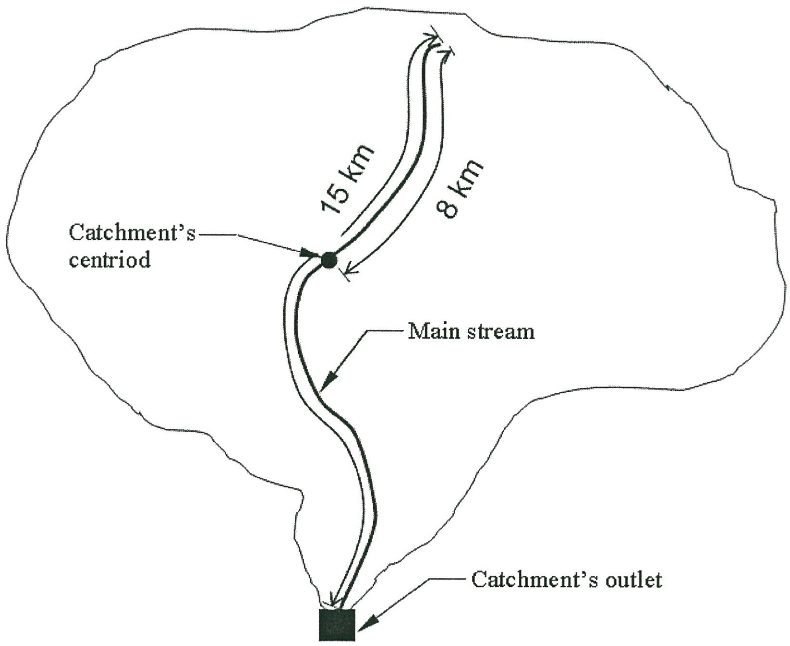


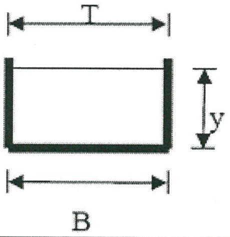
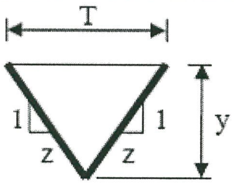
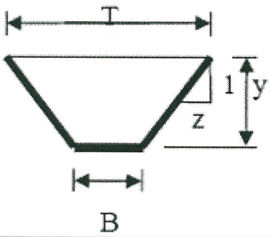
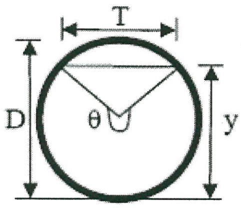
Figure Q6: Characteristics catchment for SCS method

APPENDIX

FINAL EXAMINATION

SEMESTER / SESSION : SEM I/ SESSI 2013/2014 PROGRAMME : 2 BNB
COURSE NAME : HYDRAULICS AND HYDROLOGY COURSE CODE : BNP 20103

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

APPENDIX

FINAL EXAMINATION

SEMESTER / SESSION : SEM I/ SESSI 2013/2014 PROGRAMME : 2 BNB
COURSE NAME : HYDRAULICS AND HYDROLOGY COURSE CODE : BNP 20103

TABLE

Table 1: 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)	Hydrograph Discharge Ratio (*Q*/*Q*p)
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		

APPENDIX

FINAL EXAMINATION

SEMESTER / SESSION : SEM I/ SESSI 2013/2014 PROGRAMME : 2 BNB
COURSE NAME : HYDRAULICS AND HYDROLOGY COURSE CODE : BNP 20103

FORMULAS

$Q = \frac{8}{15} C_d \sqrt{2g} \tan\theta \, H_1^{5/2}$ $Q = \frac{2}{3} C_d B \sqrt{2g} \, L_e H_1^{3/2}$ $L_e = L - (0.1nH_1)$

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

$Q = \frac{1}{n} AR^{2/3} \sqrt{S_o}$ $Cd = 0.611 + 0.075\left(\frac{H_1}{P}\right)$ $E = y + \frac{q^2}{2gy^2}$

$H_{min} = E_o - E_{min}$ $Q = \frac{1}{n} AR^{2/3} \sqrt{S_o}$ $Q = \frac{K}{\sqrt{S_o}}$

$\frac{y_2}{y_1} = \frac{1}{2}\left(-1 + \sqrt{1 + 8Fr_1^2}\right)$ $\Delta E = \frac{(y_2 - y_1)^3}{4y_1 y_2}$ $Fr_1^2 = \frac{q^2}{gy_1^3}$

$P_L = \rho g Q E_L$ $u_1 = \frac{y_1}{y_o}$ $u_2 = \frac{y_2}{y_o}$ $v_1 = u_1^{N/J}$

$v_2 = u_2^{N/J}$ $J = \frac{N}{N - M + 1}$ $y_c = \sqrt[3]{\frac{q^2}{g}}$ $P_i = \rho Q(u_d V_{ud} - u_s V_{us})$

$$L = x_2 - x_1 = \frac{y_o}{S_o}\left\{\left[(u_2 - u_1) - \{F(u_2, N) - F(u_1, N)\} + \left(\frac{y_c}{y_o}\right)^M \left(\frac{J}{N}\right)\{F(v_2, J) - F(v_1, J)\}\right]\right\}$$

$Q = \frac{2}{3} C_d L H^{3/2} \sqrt{2g}$ $\frac{H_m}{D^2_m N^2_m} = \frac{H_p}{D^2_p N^2_p}$ $\frac{P_m}{\gamma D^5_m N^3_m} = \frac{P_p}{\lambda D^5_p N^3_p}$

$\frac{Q_m}{N_m D^3_m} = \frac{Q_p}{N_p D^3_p}$ $\frac{N_m \sqrt{Q_m}}{H_m^{3/4}} = \frac{N_p \sqrt{Q_p}}{H_p^{3/4}}$ $\eta = \frac{P_o}{P_i}$ $P_o = \gamma Q H$

$\frac{A_c^3}{T_c} = \frac{Q^2}{g}$

APPENDIX

FINAL EXAMINATION

SEMESTER / SESSION : SEM I/ SESSI 2013/2014 PROGRAMME : 2 BNB
COURSE NAME : HYDRAULICS AND HYDROLOGY COURSE CODE : BNP 20103

FORMULAS

$$P_r = \frac{t_r}{2} + t_l$$

$$t_l = C_t \left[L.L_c \right]^{0.3}$$

$$Q_p = \frac{0.208A}{P_r}$$