UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2011/2012

COURSE NAME	:	HYDRAULICS
COURSE CODE	:	BFC 21103 / BFC 2073
PROGRAMME	:	2 BFF
EXAMINATION DATE	:	JANUARY 2012
DURATION	:	3 HOURS
INSTRUCTIONS	:	ANSWER **FIVE (5)** FROM **SIX (6)** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FOURTEEN (14)** PAGES

Q1 (a) Explain briefly:

(i) Hydraulic depth
(ii) Steady flow
(iii)Reynolds number Re
(iv)Gradually varied flow
(v) Rapid varied flow
(vi)Hydraulic radius

(6 marks)

(b) Justify the difference between:

(i) Artificial and natural channel
(ii) Sewerage and flume

(5 marks)

(c) A natural trapezoidal channel with one side vertical and the other sloping at 4H : 2V carries a discharge of 55.6 m^3/s at a mean velocity of 1.5 m/s as shown in **Figure Q1**. Identify the state and the regime of the flow based on:

(i) Froude number
(ii) Reynolds number for water at 20°C

where kinematic viscosity, $\nu = 1.004 \times 10^{-6}$ m^2/s, dynamic viscosity $\mu = 1.002 \times 10^{-3}$ Ns/m^2 and density $\rho = 998.2$ kg/m^3.

If additional 35 m length of the same trapezoidal channel from the current natural channel is going to be excavated, calculate the whole cost for the excavation if the cost for excavation is RM 5.50/m^3

(9 marks)

Q2 (a) Explain the difference between:

(i) The resistance formula; Chezy and Manning
(ii) The normal depth calculation using graph and chart method
(iii) The discharge value calculation in trapezoidal and wide rectangular channel.

(6 marks)

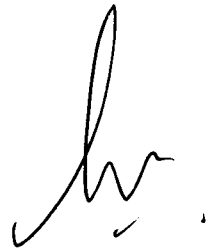
(b) A 100 m^3/s of water flows in a trapezoidal channel with a depth of flow equal to 0.75 width has a side slope of 3H:2V. If Manning, n = 0.015, bottom slope = 0.0006 and top width = 6.4 m, construct the channel width and normal depth of flow.

(6 marks)

(c) A rectangular channel of 5.4 m wide with Manning's n = 0.043 had badly-damaged surfaces. As a first stage of repair, there are two options of repairing; either to line the channel bed with concrete (n = 0.018) or to re-design using the best hydraulic section. If the depth of flow remains the same at 2.5 m before and after the repair:

(i) What is the increase of discharge obtained for both options as a result of repair?
(ii) Prove that this channel will have the maximum discharge Q_{max} using the best hydraulic section method rather than repairing the channel with the concrete lining.

(8 marks)



Q3 (a) Describe the following:

(i) Hydraulic jump
(ii) Alternate depths
(iii) Critical flow
(iv) Control section

(4 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 $n = 0.02$,

(i) Compute the normal water depth y_0.
(ii) If a broad-crested weir is to be built to control the flow, calculate the minimum height of the weir.

(7 marks)

(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

(9 marks)

Q4 (a) Explain the importance of water profile determination in a channel? Discuss the importance of determining water profile in a channel.

(5 marks)

(b) Flow enters a long rectangular flume at its upstream end of under sluice gate. The flume has bottom width of 3 m, Manning's coefficient n of 0.013 and bottom slope S_0 of 0.02. The flow depth and discharge of sluice gate at the entrance is 1.5 m and 28 m^3/s respectively. Using Direct Step method with N is 4, calculate;

(i) The length of gradually varied flow between the depth just after the sluice gate to the depth of 1.2 m downstream of the flume.

(10 marks)

(ii) The water-surface profile type

(5 marks)

Q5 (a) List **THREE (3)** types of hydraulic structures. Briefly explains the function of each structure.

(6 marks)

(b) (i) Briefly explains the measurement of flow rates in laboratory

(ii) A rectangular weir installed in laboratory has 0.65 m high and 1.8 m long as shown in **Figure Q5**. The weir is being used for discharging water from a tank under a head of 0.8 m. Calculate the discharge for this suppressed rectangular weir.

(8 marks)

(c) A triangular notch weir with a vertex angle of 75° is constructed downstream of a river. Calculate the flow rate if water flows under a head H of 2 m. Take C_d as 0.611.

(6 marks)

Q6 (a) Name **TWO (2)** types of pumps and **TWO** (2) types of turbines and briefly describes the function of pumps and turbines.

(5 marks)

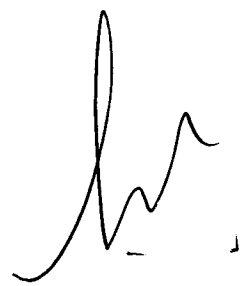
(b) Using the aid of sketches, explain the concept of series and parallel pump.

(6 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)



S1 (a) Terangkan dengan ringkas:

(i) Kedalaman hidraulik
(ii) Aliran mantap
(iii) Nombor Reynolds (Re)
(iv) Aliran berubah secara beransur
(v) Aliran berubah secara cepat
(vi) Jejari hidraulik

(6 markah)

(b) Jelaskan perbezaan di antara:

(i) Saluran buatan dengan semulajadi
(ii) Pembentung dengan flum

(5 markah)

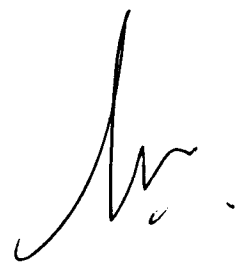
(c) Sebuah saluran trapezoid dengan satu sisi tegak dan landai pada 4H:2V mempunyai kadaralir 55.6 m^3/s pada halaju purata 1.5 m/s seperti yang ditunjukkan dalam **Rajah S1**. Tentukan keadaan dan rejim aliran air berdasarkan kepada:

(i) Nombor Froude
(ii) Nombor Reynolds bagi air pada suhu 20°C.

dimana kelikatan kinematik viscosity, $\nu = 1.004 \times 10^{-6}$ m^2/s, kelikatan dinamik $\mu = 1.002 \times 10^{-3}$ Ns/m^2 dan ketumpatan $\rho = 998.2$ kg/m^3

Jika tambahan 35 m panjang bagi saluran semulajadi trapezoid yang sama daripada saluran yang sedia ada hendak digali, kirakan kos keseluruhan untuk penggalian jika kos untuk penggalian ini adalah RM 5.50/m^3.

(9 markah)



S2 (a) Terangkan perbezaan di antara:

(i) Formula rintangan: Chezy dan Manning
(ii) Kaedah pengiraan bagi ukur dalam normal menggunakan graf dan carta
(iii)Kaedah pengiraan bagi kadaralir di dalam saluran trapezoid dan saluran segi empat yang lebar

(6 markah)

(b) Saluran trapezoid mengalirkan air pada kadar 100 m^3/s pada kedalaman 0.75 daripada lebar saluran ($0.75 \times B$) dan mempunyai cerun sisi 3H:2V. Jika Manning n = 0.015, cerun dasar = 0.0006 dan lebar atas = 6.4 m, cari lebar saluran B dan ukur dalam normal y_o aliran.

(6 markah)

(c) Saluran segi empat tepat dengan lebar 5.4 m dan Manning n = 0.043 mempunyai permukaan dasar yang rosak. Pada peringkat pertama pembaikan, terdapat dua pilihan untuk membaik pulih; sama ada menggantikan lapisan saluran dengan konkrit (n = 0.018) atau merekabentuk semula saluran menggunakan keratan hidraulik berkesan. Jika kedalaman aliran adalah sama iaitu 2.5 m sebelum dan selepas pembaikan:

(i) Kira peningkatan kadar alir yang diperolehi bagi kedua-dua pilihan daripada sebelum pembaikan.
(ii) Buktikan bahawa saluran ini akan mempunyai kadar alir maksimum Q_{max} jika rekabentuk semula menggunakan keratan hidraulik berkesan dilakukan jika dibandingkan dengan menggantikan saluran dengan lapisan konkrit.

(8 markah)

S3 (a) Terangkan berikut:

(i) Lompatan hidraulik
(ii) Kedalaman jodoh
(iii) Aliran genting
(iv) Keratan kawalan

(4 markah)

(b) Sebuah saluran prismatik segiempat 2 m lebar mengalirkan air pada kadar tetap 12 m^3/s di atas cerun $S_0 = 0.001$ dengan pekali kekasaran Manning $n = 0.02$,

(i) Kira ukur dalam air normal y_0.
(ii) Jika sebuah empang dasar dibina untuk mengawal aliran, kira ketinggian minimum empang tersebut.

(7 markah)

(c) Lompatan hidraulik telah berlaku di saluran segiempat yang mendatar. Jika nombor Froude sebelum lompatan, Fr_1 adalah 12.0 m dan kehilangan turus tenaga, E_L diberi sebanyak 4.2 m, tentukan;

(i) Kedalaman jodoh, y_1 dan y_2
(ii) Ketinggian lompatan,
(iii) Kadaralir per meter lebar,
(iv) Kuasa yang terlesap per meter lebar

(9 markah)

S4 (a) Bincangkan kepentingan penentuan susuk aliran dalam sebuah saluran

(5 marks)

(b) Aliran memasuki flum segiempat yang panjang di akhir hulu saliran selepas melalui bawah pintu air sluis. Flum mempunyai b = 3 m, n = 0.013 dan S_0 = 0.02. Kedalaman aliran di pintu masuk adalah 1.5 m dan aliran adalah 28 m^3/s. Dengan menggunakan kaedah Langkah Terus dengan N langkah = 4, kira;

(i) Panjang aliran selepas melalui pintu air sluis untuk kedalaman di hilir adalah 1.2 m. (Gunakan Kaedah Langkah Terus dengan N langkah = 4).

(10 marks)

(ii) Jenis profil permukaan air

(5 marks)

S5 (a) Senaraikan **TIGA (3)** jenis stuktur hidraulik. Terangkan fungsi atau kegunaan setiap struktur hidraulik tersebut

(6 markah)

(b) (i) Terangkan secara ringkas pengukuran kadar alir Q di dalam makmal.
(ii) Sebuah sempak segiempat di dalam makmal mempunyai ketinggian 0.65 m dan 1.8 m lebar seperti dalam **Rajah S5**. Sempak ini digunakan untuk mengalirkan air daripada tangki yang mempunyai ketinggian turus 0.8 m. Kirakan kadaralir yang melalui sempak segiempat yang tidak digentingkan ini.

(8 markah)

(c) Sebuah sempak segitiga dengan sudut 75° dibina di hilir sebuah sungai. Kira kadar alir Q jika ketinggian turus H ialah 2 m. Ambil C_d = 0.611.

(6 markah)

S6 (a) Namakan **DUA (2)** jenis pam dan **DUA (2)** jenis turbin dan secara ringkas gambarkan fungsi pam dan turbin ini.

(6 markah)

(b) Dengan bantuan gambarajah, terangkan konsep pam bersiri dan selari.

(6 markah)

(c) Sebuah pam empar dapat mengepam 0.02 m^3/s melalui turus 16 m pada kelajuan 1500 psm. Garis pusat pendesak ialah 0.4 m dan kuasa brek ialah 5 kW. Sebuah pam lain yang mempunyai keserupaan geometri bergaris pusat 0.38 m berputar pada kelajuan 1750 psm. Dengan menganggap kedua-duanya mempunyai kecekapan yang sama, tentukan:

(i) berapakah turus yang terhasil ?
(ii) berapa banyak air yang dapat dipam?
(iii) berapakah kuasa yang dihasilkan ?

(8 markah)

APPENDIX 1

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2011/2012 PROGRAMME : 2 BFF
COURSE NAME : HYDRAULICS COURSE CODE : BFC 21103 / BFC 2073

TABLE

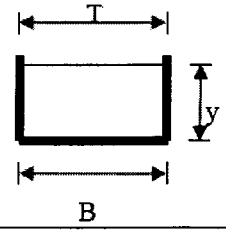
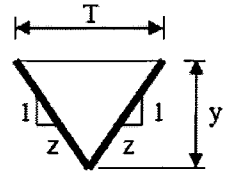
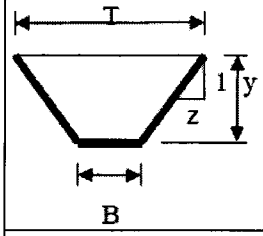
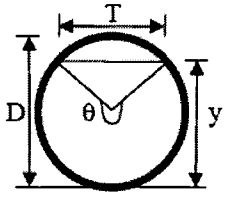
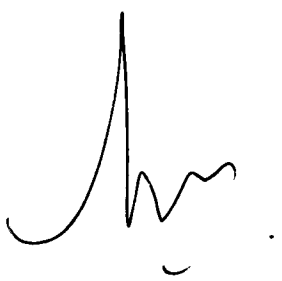
Bentuk	A	T	P
	By	B	B + 2y
	zy^2	2zy	$2y\sqrt{1+z^2}$
	$By + zy^2$	B + 2zy	$B + 2y\sqrt{1+z^2}$
	$\frac{D^2}{8}(\theta - \sin\theta)$ θ dalam radian	$D(\sin\frac{\theta}{2})$ atau $2\sqrt{y(D-y)}$	$\frac{\theta D}{2}$ θ dalam radian

Table Q1
Jadual S1



FINAL EXAMINATION

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COURSE NAME: HYDRAULICS COURSE CODE : BFC 21103 / BFC 2073

FIGURES

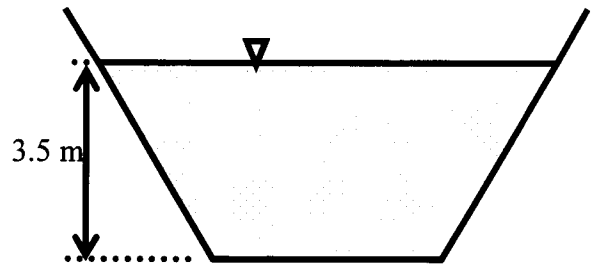


Figure Q1
Rajah S1

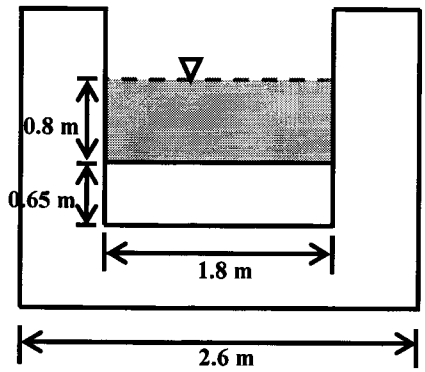
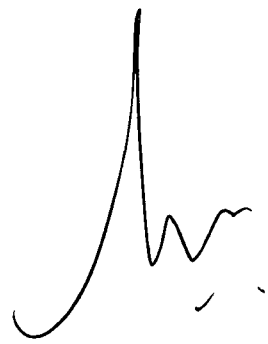


Figure Q5
Rajah S5



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EQUATIONS

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

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

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

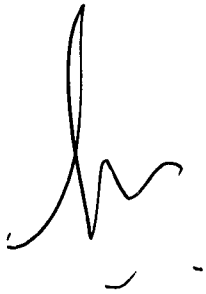
$$h_l = \frac{(y_2 - y_1)^3}{4y_1 y_2} \qquad P_l = \rho g Q E_l \qquad \Delta z_{min} = E_0 - E_{min}$$

$$dx = \frac{\left(y_2 + \left(\frac{v_2^2}{2g}\right)\right) - \left(y_1 + \left(\frac{v_1^2}{2g}\right)\right)}{S_o - S_{ave}} \qquad F_r = \frac{V}{\sqrt{gy}} \qquad i = \frac{n^2 v^2}{R^{4/3}}$$

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

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

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



Q4 – b (i) With the aid of Table Q4, calculate the length of gradually varied flow between the depth just after the sluice gate to the depth of 1.2 m downstream of the flume. (Please fill in the blanks in Table Q4, and please return this paper with the answer script)

Q4 – b (i) Dengan bantuan Jadual S4, kirakan panjang aliran selepas melalui pintu air sluis untuk kedalaman di hilir adalah 1.2 m. (Sila isikan ruang kosong dalam Jadual S4, dan kembalikan bersama skrip jawapan)

Table Q4
Jadual S4

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
N'	y	A	P	R	v	$\frac{v^2}{2g}$	E	ΔE	$S \times 10^{-3}$	$S_{ave} \times 10^{-3}$	$S_o - S_{ave} \times 10^{-4}$	$\Delta x = \frac{(8)}{(11)}$
0'												
1												
2												
3												
4												
											$L = \sum \Delta x =$	m

Correction for Hydraulic BFC 2073 / BFC 21103

Q1 (c) - A natural trapezoidal channel **with side slope at 4H : 2V** carries a discharge of 55.6 m^3/s at a mean velocity of 1.5 m/s as shown in **Figure Q1.**

Correction in Figure Q1,

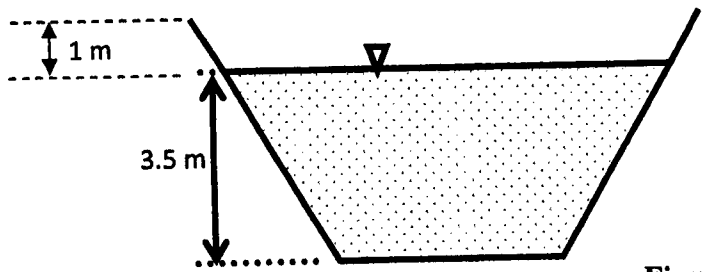


Figure Q1
Rajah S1

Q2 - Correction in Question 2 (c) :

1. **Bed slope, S_o is 0.0006,**
2. **..re-design using the best hydraulic section using *n* for concrete, *n* = 0.018**
3. **The width, B of the channel is changes from ~~5.4~~ meter to 3 meter**

Correction for Hydraulic BFC 2073 / BFC 21103

Q1 (c) - A natural trapezoidal channel **with side slope at 4H : 2V** carries a discharge of 55.6 m^3/s at a mean velocity of 1.5 m/s as shown in **Figure Q1**.

Correction in Figure Q1,

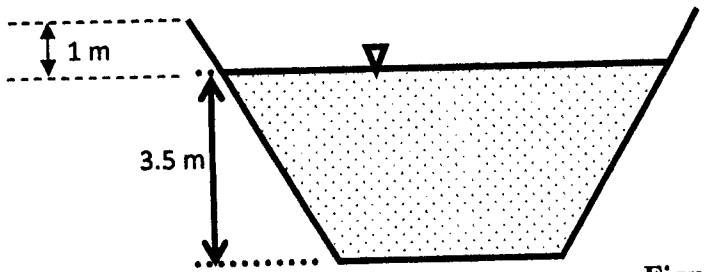


Figure Q1
Rajah S1

Q2 - Correction in Question 2 (c) :

1. **Bed slope, S_o is 0.0006,**
2. **..re-design using the best hydraulic section using *n* for concrete, $n = 0.018$**
3. **The width, B of the channel is changes from ~~5.4~~ meter to 3 meter**

Q4 – b (i) With the aid of Table Q4, calculate the length of gradually varied flow between the depth just after the sluice gate to the depth of 1.2 m downstream of the flume. (Please fill in the blanks in Table Q4, and please return this paper with the answer script)

Q4 – b (i) Dengan bantuan Jadual S4, kirakan panjang aliran selepas melalui pintu air sluis untuk kedalaman di hilir adalah 1.2 m. (Sila isikan ruang kosong dalam Jadual S4, dan kembalikan bersama skrip jawapan)

Table Q4
Jadual S4

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
N'	y	A	P	R	v	$\frac{v^2}{2g}$	E	ΔE	$S \times 10^{-3}$	$S_{ave} \times 10^{-3}$	$S_0 - S_{ave} \times 10^{-4}$	$\Delta x = \frac{(8)}{(11)}$
0'												
1												
2												
3												
4												
											$L = \sum \Delta x =$	m