UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	HYDRAULICS
COURSE CODE	:	BFC 2073 / BFC 21103
PROGRAMME	:	2 BFF
EXAMINATION DATE	:	JUNE 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS PAPER CONSISTS OF **NINE (9)** PAGES

Q1 (a) Based on **Table Q1**, explain the influence of channel surface to flow resistance.

Table Q1

Roughness coefficient, *n*			
Natural Channel		Artificial channel	
Clean and straight	0.030	Cement (mortar)	0.013
Mountain river	0.040	Asphalt (rough)	0.016
Vegetation	0.100	Concrete	0.017

(5 marks)

(b) Water flows uniformly at 3.5 m^3/s in 3.0 m diameter of a circular channel with channel slope of 0.0012 and Chezy's coefficient of 65 $m^{0.5}/s$. Determine the normal depth using trial and error method.

(15 marks)

Q2 (a) Define the maximum constriction width, B_{2max} and state the conditions that are not causing the changes of upstream water depth before the constriction structure.

(4 marks)

(b) A long rectangular channel 3.5 m width with Manning *n* of 0.015 and bottom slope of 0.0008 conveys water at 11.5 m^3/s. If the constriction is done with 3.0 m width, calculate the water depths at upstream and downstream of the constriction. Sketch the flow profile utilizing all values obtained.

(16 marks)

Q3 (a) With the aid of sketches, explain the 3 types of flow profiles in a steep channel.

(6 marks)

(b) A rectangular channel of width of 1.5 m, Manning's coefficient, *n* of 0.035 and bottom slope of 0.0015 is used to convey water at a normal depth of 4.2 m. As water travels to the downstream of the channel the depth has raised to 1.8 m due to the presence of a broad-crested weir. Using the Direct Step Method :-

(i) Calculate the length of the gradually varied flow profile starting from 6 % higher of the normal depth in 4 stages.

(ii) Sketch the increment of each depth of flow profile with respect to its horizontal distance and state the type of the flow profile. (Use **Table Q3** – attach the table with your answer booklet).

(14 marks)

Q4 (a) Give **THREE (3)** conditions where hydraulic jumps can occur and sketch the water depths profiles associated with these jumps.

(6 marks)

(b) A rectangular channel of 4.2 m wide, carries flow of 22 m^3/s. At a certain location the channel slope changes abruptly from 0.02 to 0.001. Determine whether a hydraulic jump would occur and if it occurs, determine the position of the jump and energy dissipated. (Given $n = 0.013$).

(14 marks)

Q5 (a) A hydraulic dam is the combination of several hydraulic structures. Explain the function of each structure.

(6 marks)

(b) An underflow sluice gate was built to control water level as well as to prevent the intrusion of sea water. The channel is rectangular with bottom width, b = 2.3 m. The velocity below the sluice gate and the upstream water depth are 5.0 m/s and 1.7 m, respectively. Calculate the discharge if the height of gate opening is 0.5 m, the downstream flow depth is 1.4 m and the coefficient of discharge, C_d is 0.598.

(7 marks)

(c) A contracted rectangular weir as shown in **Figure Q5** is used to control flow in an irrigation system. Calculate the discharge of the channel.

(7 marks)

Q6 (a) With the aid of flow rates, Q against pressure head, H graph, explain the operation of pumps which are installed in series and in parallel.

(6 marks)

(b) A model study of a centrifugal pump obtained the following characteristics :-

N	1200 rotating/min
Q	0.91 m^3/min
H	47 m
e	85 %

The diameter of the impeller is 50 cm. If the prototype pump of 0.8 m diameter is to be designed, determine the :-

(i) Operation speed to convey 0.1 m^3/s of water.
(ii) Head of water achieved at flow of 0.1 m^3/s.
(iii) Power required to operate the pump.

(14 marks)

- END OF QUESTION -

S1 (a) Berdasarkan **Jadual S1**, jelaskan pengaruh permukaan saluran terhadap rintangan aliran.

Jadual S1

Pekali kekasaran, n			
Saluran semulajadi		Saluran buatan	
Bersih dan lurus	0.030	Simen (mortar)	0.013
Sungai gunung	0.040	Asfalt (kasar)	0.016
Tumbuhan	0.100	Konkrit	0.017

(5 markah)

(b) Air mengalir secara seragam pada 3.5 m^3/s di dalam sebuah saluran bulat berdiameter 3.0 m dengan cerun saluran 0.0012 dan pekali Chezy 65 $m^{0.5}/s$. Tentukan ukurdalam normal menggunakan kaedah cuba dan ralat.

(15 markah)

S2 (a) Takrifkan lebar maksimum penggentingan, B_{2max} dan nyatakan keadaan-keadaan yang tidak mengakibatkan perubahan ukurdalam air dihulu sebelum struktur penggentingan.

(4 markah)

(b) Sebuah saluran panjang segiempat tepat 3.5 m lebar dengan Manning n 0.015 dan cerun dasar 0.0008 mengalirkan air sebanyak 11.5 m^3/s. Jika penggentingan dilakukan dengan lebar 3.0 m, kira ukur dalam air di hulu dan di hilir penggentingan. Lakarkan bentuk profil aliran dengan menggunapakai semua nilai yang diperolehi.

(16 markah)

S3 (a) Dengan bantuan lakaran, huraikan 3 jenis profil aliran di dalam saluran curam.

(6 markah)

(b) Sebuah saluran segiempat dengan kelebaran 1.5 m, pekali Manning n 0.035 dan cerun dasar 0.0015 digunakan untuk mengalirkan air dengan kedalaman normal 4.2 m. Semasa air merentasi hilir saluran ukurdalam air meningkat sebanyak 1.8 m disebabkan oleh kehadiran empang berpuncak lebar. Menggunakan kaedah berperingkat :-

(i) Kira jarak profil aliran berubah beransur bermula 6% lebih tinggi daripada kedalaman normal dalam 4 peringkat.

(ii) Lakarkan peningkatan setiap ukurdalam profil aliran berbanding jarak mendatarnya dan nyatakan jenis profil aliran ini. (Gunakan **Jadual S3** - lampirkan jadual ini dengan buku jawapan anda).

(14 markah)

S4 (a) Berikan **TIGA (3)** keadaan dimana lompatan hidraulik boleh berlaku dan lakarkan profil ukurdalam air yang berkaitan dengan lompatan lompatan ini.

(6 markah)

(b) Sebuah saluran segiempat tepat dengan lebar 4.2 m mengalirkan air sebanyak 22 m^3/s. Di suatu lokasi, cerun saluran berubah serta-merta dari 0.02 ke 0.001. Tentukan samada lompatan hidraulik akan berlaku dan sekiranya berlaku, tentukan kedudukan lompatan hidraulik dan tenaga yang dilesapkan. (Diberikan $n = 0.013$).

(14 markah)

S5 (a) Sebuah empangan hidraulik ialah kombinasi beberapa struktur hidraulik. Huraikan fungsi setiap stuktur tersebut.

(6 markah)

(b) Satu pintu sluis aliran dasar telah dibina untuk mengawal paras air dan juga untuk mengelakkan penerobosan air laut. Saluran adalah berbentuk segiempat tepat dengan lebar, b = 2.3 m. Halaju di bawah pintu sluis dan ukurdalam air di hulu ialah masing-masing 5.0 m/s dan 1.7 m. Kira kadar alir sekiranya tinggi bukaan pintu sluis ialah 0.5 m, kedalaman aliran di hilir ialah 1.4 m dan pekali kadar alir C_d ialah 0.598.

(7 markah)

(c) Sebuah sempak segiempat tepat disempitkan seperti dalam **Rajah S5** digunakan untuk mengawal aliran sebuah sistem pengairan. Kirakan kadar alir untuk saluran ini.

(7 markah)

S6 (a) Dengan bantuan graf kadar alir Q melawan turus tekanan H, huraikan operasi pam-pam yang dipasang secara sesiri dan selari.

(6 markah)

(b) Suatu kajian model sebuah pam empar memperolehi ciri-ciri berikut :-

N	1200 pusingan/min
Q	0.91 m^3/min
H	47 m
e	85 %

Diameter pendesak ialah 50 cm. Jika pam prototaip berdiameter 0.8 m perlu direkabentuk, tentukan :-

(i) Kelajuan operasi untuk penghantaran 0.1 m^3/s air.
(ii) Turus yang dapat dicapai pada aliran 0.1 m^3/s.
(iii) Kuasa yang diperlukan untuk menggerakkan pam.

(14 markah)

- SOALAN TAMAT -

APPENDIX I

FINAL EXAMINATION

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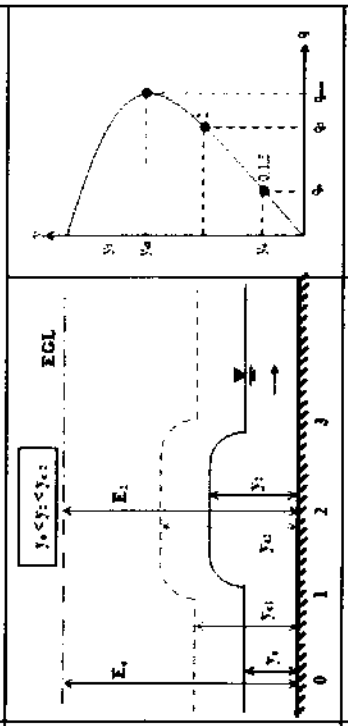
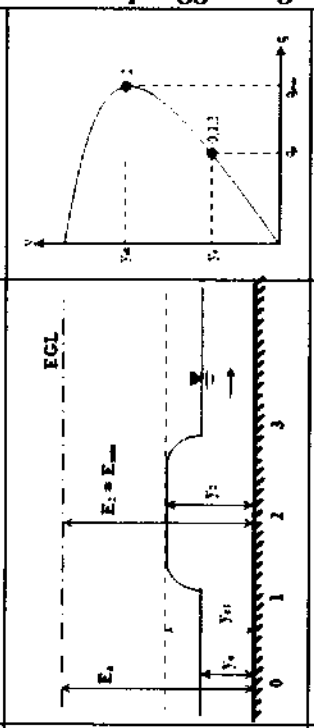
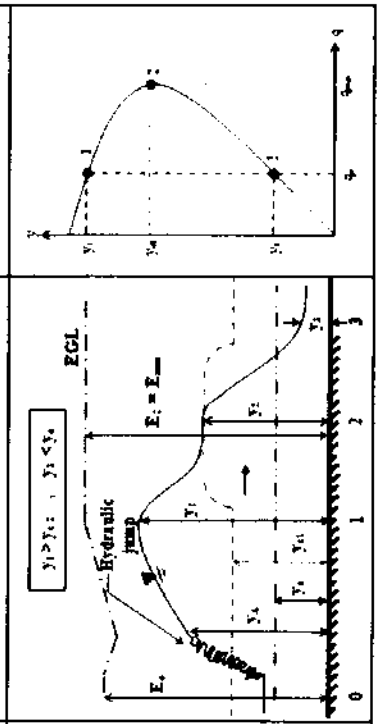
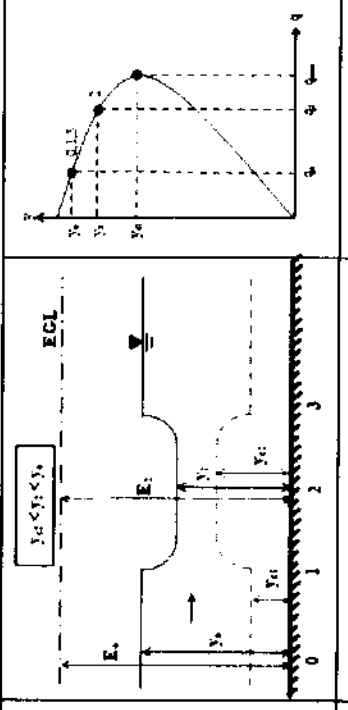
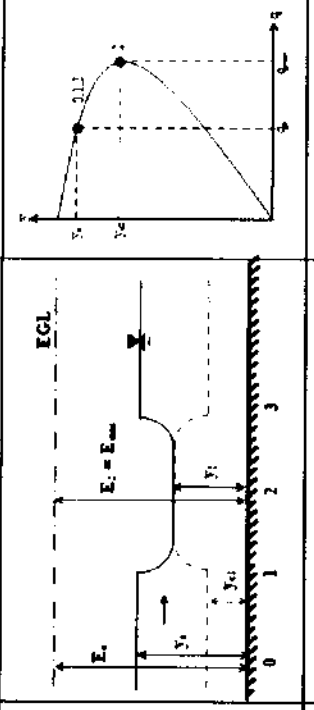
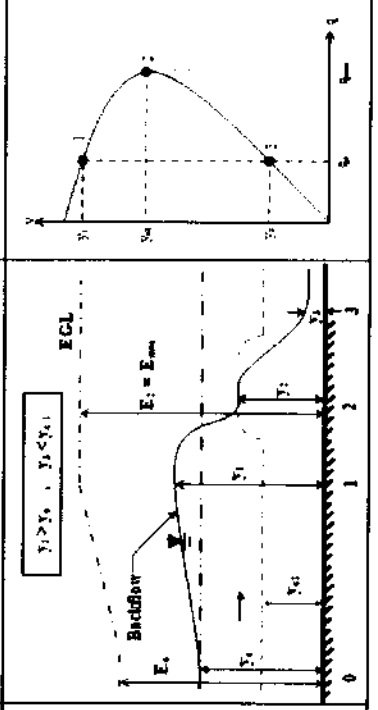
Table Q2 : Characteristics of channel constriction /
Jadual S2 : Ciri-ciri penggentingan saluran

	CASE 1	CASE 2	CASE 3
SUPERCRITICAL AT POINT O ($y_o < y_{co}$)			
SUBCRITICAL AT POINT O ($y_o > y_{co}$)			
CONDITION	$E_{min} + H < E_o$ or $B_2 > B_{2max}$ $y_1 = y_3 = y_o$ & $y_2 \neq y_{c2}$ ➤ $E_2 = E_o - H$	$E_{min} + H = E_o$ or $B_2 = B_{2max}$ $y_2 = y_{c2} = y_o$ & $y_1 = y_3 = y_o$	$E_{min} + H > E_o$ or $B_2 < B_{2max}$ $y_2 = y_{c2}$; y_1 & y_3 ➤ $E_{1,3} = E_{min} + H$

APPENDIX II

FINAL EXAMINATION

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TABLE / *JADUAL*

Please attach this table with your answer sheet

Name : _____ **Matrix No. :** _____ **Section :** _____

Table Q3 / Jadual S3

N'	y	A	P	R	v	$v^2/2g$	E	ΔE	S	S_{ave}	$S_o - S_{ave}$	Δx

(Answer is limitied to 3 decimal points)
(Jawapan dihadkan kepada 3 titik perpuluhan)

APPENDIX III

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TABLE / *JADUAL*

Geometric elements of a channel /
Elemen-elemen geometri saluran

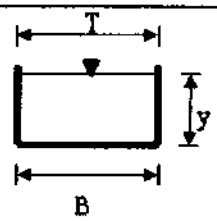
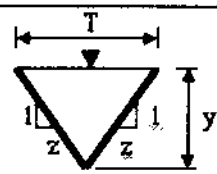
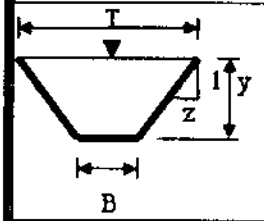
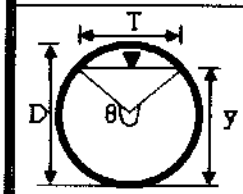
Shape	A	T	P
	By	B	B + 2y
	zy^2	2zy	$2y\sqrt{1+z^2}$
	$By + zy^2$	B + 2zy	$B + 2y\sqrt{1+z^2}$
	$\frac{D^2}{8}(\theta - \sin\theta)$ θ in radian	$D\left(\sin\frac{\theta}{2}\right)$ or $2\sqrt{y(D-y)}$	$\frac{\theta D}{2}$ θ in radian

FIGURE / *RAJAH*

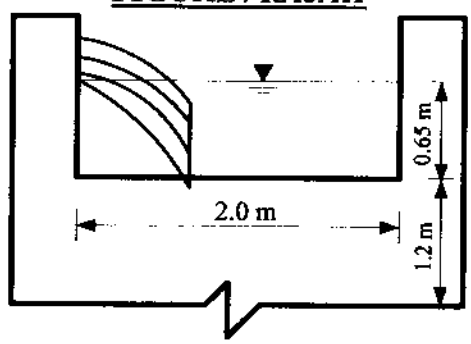


Figure Q5 / *Rajah S5*

APPENDIX IV

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EQUATIONS / *PERSAMAAN-PERSAMAAN*

$$C_E = \left[0.607 + \frac{0.00451}{H}\right]\left[1 + 0.55\left(\frac{H}{P-H}\right)^2\right] \qquad P_o = \rho g Q H$$

$$C_d = 0.611 + 0.075\left(\frac{H}{P}\right) \qquad L_e = L - 0.1nH \qquad Q = \frac{2}{3}C_d\sqrt{2g}LH^{\frac{3}{2}}$$

$$Q = \frac{2}{3}C_d\sqrt{2g}L_eH^{\frac{3}{2}} \qquad Q = \frac{1}{n}AR^{2/3}\sqrt{S_o} \qquad Q = CA\sqrt{RS_o}$$

$$y_c = \sqrt[3]{\frac{q^2}{g}} \qquad B_{2\max} = \frac{Q}{\sqrt{g\left[\frac{2}{3}(E_o - H)\right]^3}} \qquad E = y + \frac{q^2}{2gy^2}$$

$$E = y + \frac{v^2}{2g} \qquad y_o = \frac{D}{2}\left[1 - \cos\left(\frac{\theta}{2}\right)\right] \qquad \Delta x = \frac{\Delta E}{S_o - S_{ave}}$$

$$S_{ave} = \frac{S_{i+1} + S_i}{2} \qquad S = \left(\frac{nv}{uR^{2/3}}\right)^2 \qquad \frac{y_2}{y_1} = \frac{1}{2}\left[-1 + \sqrt{1 + 8Fr_1^2}\right]$$

$$Fr_1^2 = \frac{q^2}{gy_1^3} \qquad L_j = \frac{E_1 - E_2}{i - S_o} \qquad i = \left[\frac{nv_m}{R_m^{2/3}}\right]^2 \qquad E_L = \frac{(y_2 - y_1)^3}{4y_2y_1}$$

$$Q = C_d.ab\sqrt{2g(y_o - y_1)} \qquad v_1 = \sqrt{2g(y_o - y_1)} \qquad Q = C_d.ab\sqrt{2g(y_o - y_2)}$$

$$\frac{H_m}{D_m^2N_m^2} = \frac{H_p}{D_p^2N_p^2} \qquad \frac{Q_m}{N_mD_m^3} = \frac{Q_p}{N_pD_p^3} \qquad \Delta y = \frac{y_{\text{start limit}} - y_{\text{end limit}}}{N'}$$

$$N_{sm} = N_{se} = \left(\frac{N_m\sqrt{Q_m}}{H_m^{3/4}}\right) = \left(\frac{N_e\sqrt{Q_e}}{H_e^{3/4}}\right) \qquad \frac{P_m}{\gamma_m D_m^5 N_m^3} = \frac{P_p}{\gamma_p D_p^5 N_p^3} \qquad n_o = \frac{P_o}{P_i}$$