Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

PEPERIKSAAN AKHIR
SEMESTER II
SESI 2014/2015

NAMA KURSUS	:	HIDRAULIK
KOD KURSUS	:	BFC 21103
PROGRAM	:	SARJANA MUDA KEJURUTERAAN AWAM DENGAN KEPUJIAN
TARIKH PEPERIKSAAN	:	JUN 2015 / JULAI 2015
JANGKA MASA	:	3 JAM
ARAHAN	:	JAWAB: (A) **SEMUA** SOALAN DALAM **BAHAGIAN A**, DAN (B) **MANA-MANA DUA (2)** SOALAN DALAM **BAHAGIAN B**

KERTAS SOALAN INI MENGANDUNGI **SEBELAS (11)** MUKA SURAT

BAHAGIAN A: JAWAB **SEMUA** SOALAN

S1 (a) Takrifkan yang berikut:
(i) Saluran prismatik
(ii) Aliran tetap

(2 markah)

(b) Sebuah saluran majmuk seperti dalam **RAJAH S1(b)** membawa aliran pada ukur dalam 1.2 m di atas cerun memanjang 0.002 dan kekasaran Manning n = 0.013. Kira kadar alir Q.

(12 markah)

(c) Sebuah saluran segiempat 3 m lebar menghantar aliran pada 12000 L/s di bawah ukur dalam seragam 0.75 m. Tentukan keadaan aliran berdasarkan
(i) Nombor Reynolds ($\nu = 1.004 \times 10^{-6}$ m^2/s)
(ii) Nombor Froude

(6 markah)

S2 (a) Jelaskan **dua (2)** kebaikan dalam penggunaan keratan hidraulik paling berkesan.

(3 markah)

(b) Sebuah saluran trapezoid akan direka bentuk untuk membawa kadar alir 75 m^3/s pada keberkesanan hidraulik maksimum. Jika cerun sisi saluran ialah 2(H) : 1(V), pekali kekasaran Manning n ialah 0.03, dan halaju maksimum yang dibenarkan ialah 1.75 m/s, kira
(i) Dimensi saluran tersebut B dan y_o
(ii) Cerun memanjang saluran tersebut

(17 markah)

S3 Sebuah saluran segiempat 2.5 m lebar mengalirkan 2 m^3/s aliran pada ukur dalam 0.8 m. Jika sebuah empang dasar berpuncak lebar berketinggian 0.35 m dibina dalam saluran tersebut,

(a) Lakarkan lengkung E-y dengan memberi nilai E_1, y_1, E_{min}, dan y_c.

(4 markah)

(b) Tentukan ukur dalam aliran di hulu, di atas empang dan di hilir empang dasar tersebut.

(12 markah)

(c) Tentukan ubahsuai yang perlu dilakukan ke atas lebar dasar di keratan empang untuk memastikan ukur dalam aliran hulu kekal pada 0.8 m.

(4 markah)

BAHAGIAN B: JAWAB **MANA-MANA DUA (2)** SOALAN

S4 (a) Jelaskan dengan ringkas **dua (2)** andaian yang digunakan dalam analisis aliran berubah beransur.

(3 markah)

(b) Satu lompatan hidraulik berlaku dalam sebuah saluran segiempat dengan aliran 25 m^3/s dan menyebabkan kehilangan kuasa sebanyak 82,909 W. Jika nisbah ukur dalam - ukur dalam konjugat ialah 0.567, kira

(i) Ketinggian lompatan
(ii) Jenis lompatan
(iii) Lebar saluran

(8 markah)

(c) Sebuah saluran seperti dalam **RAJAH S4(c)** mempunyai lebar 5.0 m, pekali kekasaran Manning 0.017, cerun dasar 1:500 dan ukur dalam normal 1.45 m. Aliran berubah daripada ukur dalam normal di A kepada ukur dalam kritikal di B. Menggunakan kaedah Kiraan Berperingkat dengan $N = 4$ langkah, tentukan

(i) Jenis profil aliran berubah beransur
(ii) Panjang profil aliran berubah beransur tersebut (sila guna **JADUAL S4(c)** dan hantar jadual bersama kertas jawapan).

(9 markah)

S5 (a) Sebuah pintu sluis dibina dalam saluran segiempat 1.5 m lebar yang mempunyai ukur dalam seragam $y_o = 0.3$ m, pekali kadar alir $C_d = 0.605$, dan bukaan pintu $a = 0.127$ m. Lompatan hidraulik berlaku di hilir. Jika ukur dalam aliran sebelum lompatan hidraulik $y_1 = 0.189$ m, kira

(i) Ukur dalam konjugat y_2 lompatan hidraulik tersebut
(ii) Kadar alir melalui alur limpah

(7 markah)

(c) Sebuah empang berpuncak tajam dibina dalam sebuah saluran segiempat yang mengalirkan aliran di bawah turus 0.2 m dan $C_d = 0.6$. Kira kadar alir jika keratan empang berikut digunakan:

(i) empang segiempat 1-m lebar
(ii) empang trapezoid dengan lebar dasar 1 m dan cerun sisi 1(H) : 1(V)

(6 markah)

(d) Sebuah alur limpah segiempat 5 m lebar mengalirkan aliran banjir pada kadar 125 m^3/s dan ukur dalam 1.2 m. Di kaki alur limpah, reka bentuk sebuah kolam penenang USBR Jenis III.

(7 markah)

S6 (a) Jelaskan fungsi mesin hidraulik berikut:
(i) Pam
(ii) Turbin

(3 markah)

(b) Pam diperlukan untuk membekalkan 22,000 L/s air ke sebuah kawasan perumahan di bawah turus 18 m. Jika 2 pam seiras dipasang secara sesiri digunakan, kira
(i) Kuasa keluaran yang diperlukan oleh setiap pam, dan
(ii) Kuasa masukan setiap pam jika kecekapan ialah 75% dan daya aci ialah 11 kNm.

(10 markah)

(c) Sebuah turbin dengan kecekapan 82.5% dibekalkan dengan aliran air 25 m^3/s di bawah turus 25 m. Kira:
(i) Kuasa aliran
(ii) Kuasa aci turbin
(iii) Kuasa aci sebuah model 1:6 di bawah turus 1.5 m

(7 markah)

- SOALAN TAMAT -

SECTION A: *ANSWER **ALL** QUESTIONS*

Q1 *(a)* *Define the following:*
(i) Prismatic channel
(ii) Steady flow

(2 marks)

(b) *A compound channel shown in **FIGURE Q1(b)** carries flow at a depth of 1.2 m on longitudinal slope of 0.002 and Manning roughness n = 0.013. Calculate the discharge Q.*

(12 marks)

(c) *A 3 m wide rectangular channel conveys flow at 12000 L/s under the uniform depth of 0.75 m. Determine the state of flow based on*
(i) Reynolds number ($\nu = 1.004 \times 10^{-6}$ m^2/s)
(ii) Froude number

(6 marks)

Q2 *(a)* *Explain **two (2)** advantages in using best hydraulic section.*

(3 marks)

(b) *A trapezoidal channel is to be designed to carry a discharge of 75 m^3/s at maximum hydraulic efficiency. If the side slope of the channel is 2(H) : 1(V), Manning roughness coefficient n is 0.03, and maximum allowable velocity is 1.75 m/s, calculate*
(i) Dimensions of the channel B and y_o
(ii) Longitudinal slope of the channel

(17 marks)

Q3 *A 2.5-m wide rectangular channel discharges 2 m^3/s flow at a uniform depth of 0.8 m. If a 0.35 m-high broad-crested weir is to be built in the channel,*

(a) *Sketch the E-y curve providing E_1, y_1, E_{min}, and y_c.*

(4 marks)

(b) *Determine the depths of flow at upstream, above and downstream of the weir.*

(12 marks)

(c) *Determine the channel width modification at the weir to ensure the depth of upstream flow remains 0.8 m.*

(4 marks)

SECTION B: *ANSWER **ANY TWO** (2) QUESTIONS*

Q4 *(a)* *Briefly explain the **two (2)** assumptions used in the analysis of gradually varied flow.*

(3 marks)

(b) *A hydraulic jump occurs within a rectangular channel with flow 25 m^3/s causing the loss of power as much as 82,909 W. If ratio of the conjugate depths is 0.567, calculate*

(i) *Height of the jump*
(ii) *Type of the jump*
(iii) *Width of the channel*

(8 marks)

(c) *A rectangular channel shown in **FIGURE Q4(c)** has width of 5.0 m, Manning roughness coefficient of 0.017, bed slope of 1:500 and normal depth of 1.45 m. The flow changes from normal depth at A to critical depth at B. Using Direct Step method with N = 4 steps, determine*

(i) *Type of the gradually varied flow profile*
(ii) *Length of the gradually varied flow profile (please use **TABLE Q4(c)** and submit the table together with the answer sheet).*

(9 marks)

Q5 *(a)* *A sluice gate is built in a 1.5 m wide rectangular channel having uniform depth of y_o = 0.3 m, coefficient of discharge C_d = 0.605, and gate opening of a = 0.127 m. Hydraulic jump occurs downstream. If the depth of flow before the hydraulic jump y_1 = 0.189 m, calculate*

(i) *Conjugate depth y_2 of the hydraulic jump*
(ii) *Discharge through the spillway*

(7 marks)

(c) *A sharp-crested weir installed in a rectangular channel is discharging flow under a head of 0.2 m and C_d = 0.6. Calculate the discharge if the following weir is used:*

(i) *1-m width rectangular weir*
(ii) *1-m bottom-width trapezoidal weir with side slope 1(H) : 1(V)*

(6 marks)

(d) *A 5-m wide rectangular spillway is discharging flood flow at a rate of 125 m^3/s and depth of 1.2 m. At the toe of the spillway, design a USBR Type III stilling basin.*

(7 marks)

Q6 (a) *Explain the functions of the following hydraulic machineries:*

(i) Pump

(ii) Turbine

(3 marks)

(b) *Pump is required to supply 22,000 L/s of water for a residential area under a head of 18 m. If two identical pumps installed in series are to be used, calculate*

(i) Power delivered to the flow by each pump, and

(ii) Shaft power and speed of each pump if $\eta = 75\%$ and torque is 11 kNm.

(10 marks)

(c) *An 82.5% efficient turbine is supplied with 25 m^3/s of water with 15 m head. Calculate:*

(i) Fluid power

(ii) Shaft power of the turbine, and

(iii) Shaft power of a 1:6 model under a head of 1.5 m.

(7 marks)

- END OF QUESTION -

FINAL EXAMINATION

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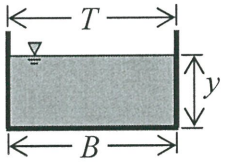
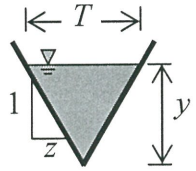
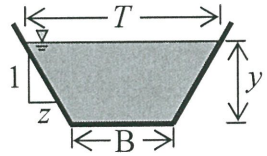
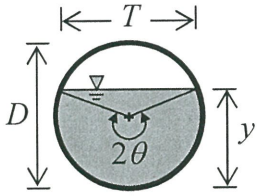
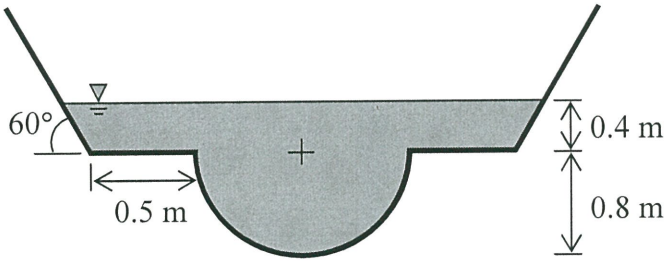
Table 1. Open channel flow section geometries

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*	$\frac{D^2}{8}(2\theta-\sin 2\theta)$	$D\sin\theta$	θD



RAJAH S1(b) / *FIGURE Q1(b)*

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Table 2. Best hydraulic sections

Cross section	*Area A*	*Wetted perimeter P*	*Hydraulic radius R*	*Top width T*	*Hydraulic depth D*
Trapezoid	$\sqrt{3}y^2$	$2\sqrt{3}y$	$\frac{y}{2}$	$\frac{4\sqrt{3}}{3}y$	$\frac{3}{4}y$
Rectangle	$2y^2$	$4y$	$\frac{y}{2}$	$2y$	y
Triangle	y^2	$2\sqrt{2}y$	$\frac{\sqrt{2}}{4}y$	$2y$	$\frac{y}{2}$
Semicircle	$\frac{\pi}{2}y^2$	πy	$\frac{y}{2}$	$2y$	$\frac{\pi}{4}y$
Parabola	$\frac{4\sqrt{2}}{3}y^2$	$\frac{8\sqrt{2}}{3}y$	$\frac{y}{2}$	$2\sqrt{2}y$	$\frac{2}{3}y$

Table 3. Sizing for USBR Type III stilling basin

Chute blocks	*Baffle blocks*	*End sill*
$h_1 = y_1$	$h_3 = y_1(0.168\mathrm{Fr}_1 + 0.63)$	$h_4 = y_1\left(\frac{\mathrm{Fr}_1}{18} + 1\right)$
$w_1 = y_1$	$w_3 = \frac{3}{4}h_3$	$t = \frac{h_3}{5}$
$s_1 = y_1$	$s_3 = \frac{3}{4}h_3$	$z_2 = 2.0$
	$t = \frac{h_3}{5}$	
	$z_1 = 1.0$	
	$L_1 = \frac{4}{5}y_2$	

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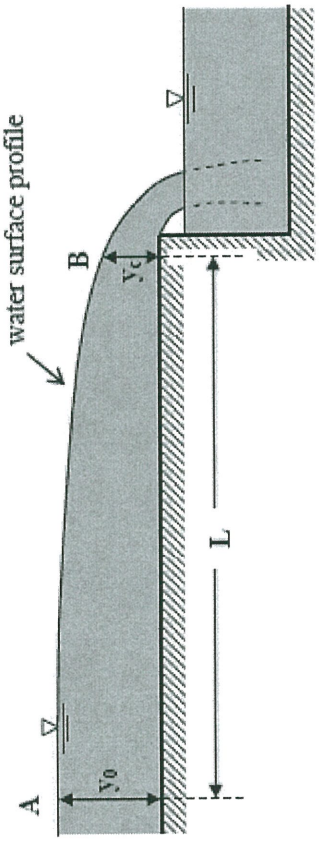
RAJAH S4(c) / *FIGURE Q4(c)*



JADUAL S4(c) / *TABLE Q4(c)*

y (m)	A (m^2)	P (m)	R (m)	V (m/s)	$\frac{V^2}{2g}$ (m)	E (m)	ΔE (m)	S_f	$\overline{S}_f$	$S_o - \overline{S}_f$	Δx (m)
										L (m)	

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***Some useful equations**:*

$$Q = AV \qquad Q = A\frac{1}{n}R^{\frac{2}{3}}S_o^{\frac{1}{2}} \qquad Q = ACR^{\frac{1}{2}}S_o^{\frac{1}{2}}$$

$$Q = C_d aB\sqrt{2g(y_o - y_1)} \text{ if } (y_o - y_1) > y_2$$
$$Q = C_d aB\sqrt{2g(y_o - y_2)} \text{ if } (y_o - y_1) \le y_2$$

$$Q = \frac{2}{3}C_d\sqrt{2g}LH_1^{\frac{3}{2}} \qquad Q = \frac{8}{15}C_d\sqrt{2g}\tan\left(\frac{\theta}{2}\right)H_1^{\frac{5}{2}}$$

$$Q = \frac{2}{3}C_d\sqrt{2g}LH_1^{\frac{3}{2}}\left(L + \frac{4}{5}H_1\tan\theta\right)$$

$$\text{Fr} = \frac{V}{\sqrt{gD}} \qquad \text{Re} = \frac{VR}{\nu}$$

$$E = y + \frac{V^2}{2g} \qquad E_{\min} = \frac{3}{2}y_c \qquad y_c = \sqrt[3]{\frac{q^2}{g}}$$

$$\frac{y_2}{y_1} = \frac{1}{2}\left(-1 + \sqrt{1 + 8\text{Fr}_1^2}\right) \qquad E_L = \frac{(y_2 - y_1)^3}{4y_1y_2}$$

$$\text{d}x = \frac{\text{d}y}{S_o}\left[\frac{1 - \left(\frac{y_c}{y_{\text{ave}}}\right)^3}{1 - \left(\frac{K_o}{K_{\text{ave}}}\right)^2}\right]$$

$$P = \gamma QH \qquad P = \frac{2\pi N}{60}T$$

$$\frac{ND}{\sqrt{H}} \qquad \frac{Q}{ND^3} \qquad \frac{P}{D^5N^3}$$