
UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2008/2009

April/May 2009

EAH 225/3 – Hydraulic
[Hidraulik]

Duration: 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **TWELVE (12)** printed pages including appendix before you begin the examination.

*[Sila pastikan kertas peperiksaan ini mengandungi **DUA BELAS (12)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions: This paper consists of **SEVEN (7)** questions. Answer **FIVE (5)** questions only. All questions carry the same marks.

*[Arahan: Kertas ini mengandungi **TUJUH (7)** soalan. Jawab **LIMA (5)** soalan sahaja. Semua soalan membawa jumlah markah yang sama.]*

You may answer the question either in Bahasa Malaysia or English.

[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

All questions **MUST BE** answered on a new page.

*[Semua soalan **MESTILAH** dijawab pada muka surat baru.]*

Write the answered question numbers on the cover sheet of the answer script.

[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]

1. a) Define the characteristics of a hydraulic jump.

[5 Marks]

- b) Water flows at a depth of 2.5 m in a rectangular channel 20.0 m wide. The bed slope is 0.001 and $n = 0.030$. Find the velocity and flow discharge under a uniform flow condition.

[5 Marks]

- c) Determine the type of flow in a trapezoidal channel with a bed width of 25.0 m, side slopes 1:1 and depth of flow of 1.5 m under uniform flow condition. The bed slope is 0.001 and $n = 0.030$.

[5 Marks]

- d) Design the section of a rectangular channel that is required to carry a discharge of 50 m^3/s at the bed slope of 0.001 and $n = 0.030$.

[5 Marks]

2. Water flow in a wide channel approaches a 10 cm-high bump at 1.5 m/s and a depth of 1 m. Compute the water depth over the bump.

[20 Marks]

3. Water discharge from a reservoir A through a 100 mm pipe 15 m long which rises to its highest point at B, 1.5 m above the free surface of the reservoir, and discharge direct to the atmosphere at C, 4 m below the free surface at A. The length of pipe l_1 from A to B is 5 m and the length of pipe from B to C is 10 m. Both the entrance and exit of the pipe are sharp and the value of f is 0.08. Calculate:

- a) The mean velocity of the water leaving the pipe at C

[10 Marks]

- b) The pressure in the pipe at B

[10 marks]

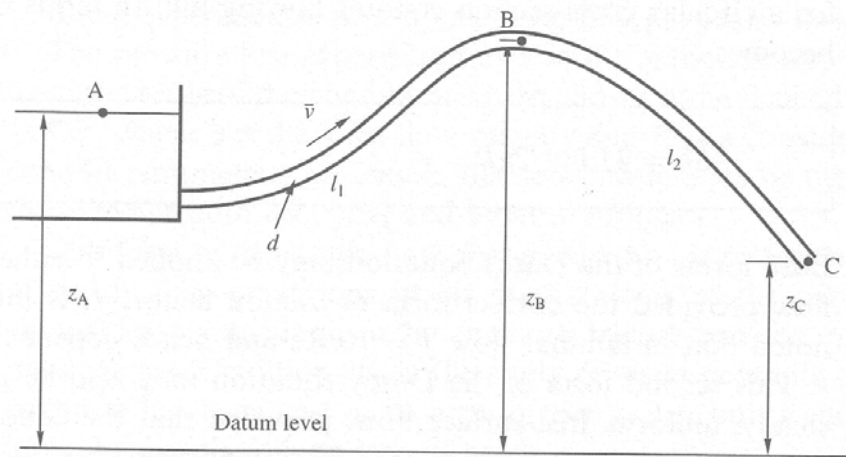


Figure 1

4. Two sharp-edged pipes of diameter $d_1 = 50$ mm, and $d_2 = 100$ mm, each of length $l = 100$ m, are connected in parallel between two reservoirs which have a difference of level $h = 10$ m. If the Darcy coefficient $f = 0.008$ for each pipe, calculate:

- a) The rate of flow for each pipe

[10 marks]

- b) The diameter D of a single pipe 100 m long which would give the same flow if it was substituted for the original two pipes.

[10 marks]

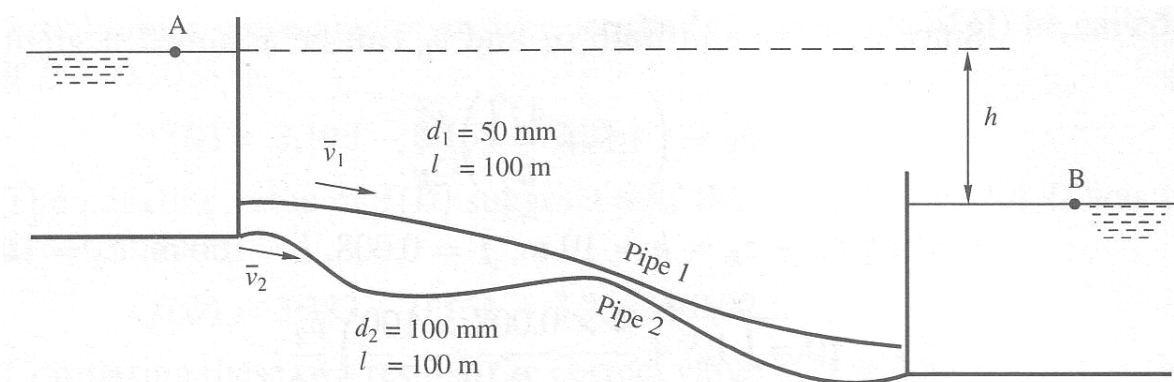


Figure 2

5. a) Lord Rayleigh was interested in the vibration of a spherical drop of diameter D which is formed when liquid issues from circular orifice. When the drop is slightly deformed from its spherical shape and left free, on account of surface tension σ it vibrates about its position of equilibrium with frequency f .

If $f =$ function of (σ, ρ, D, g) perform dimensional analysis for f .

[10 Marks]

- b) A geometrically similar model to scale 1:6 of a large centrifugal pump is tested. The prototype parameters are :

$N_p = 400$ rpm, $Q_p = 1.7$ m³/s, $H_p = 36.5$ m and $P_p = 720$ KW.

If the model is tested under head of 9 m, determine the speed and discharge at which it should run and the power required to drive it?

[10 Marks]

6. The following data were measured in Sungai Jelai near Batu Kurau.

Table 1

Flow Area	A	7.14	m ²
Hydraulic Radius	R	0.4	m
Average velocity	V	0.57	m/s
Discharge	Q	4.06	m ³ /s
Temperature	T	25.5	°C
Surface Slope	S	0.002	
Channel bed width	B	20	m
Mean sediment diameter	d_{50}	1.5	mm
Fall velocity,	W_s	0.16	m/s
Sediment shape factor		0.7	
Sediment Density,	ρ_s	2650	kg/m ³
Water Density,	ρ	1000	kg/m ³
Kinematic viscosity,	ν	1×10^{-6}	m ² /s

Calculate total bed material volumetric concentration by the following methods:-

- a) Yang's equation [8 marks]
 b) Ackers and White equation [8 Marks]
 c) Graf's equation [4 Marks]

7. The channel of following dimension was design using Critical Shear Stress approach.

Table 2

Design Discharge	Q	1.6	m
Flow Depth	D	0.65	m
Channel Slope	S	0.0006	
Angle of repose	ϕ	36	$^{\circ}$
Gravity	g	9.81	m/s^2
Sediment Specific gravity	Ss	2.65	
Channel Side slope		1.5	
Manning number	n	0.022	
Mean Sediment diameter	d_{50}	12	mm

- a) Determine the design bed width, B [10 Marks]
- b) Calculate the flow discharge using Lacey equation if a rectangular channel with bed width of 3.0 m and flow depth of 0.75 m was constructed. [4 Marks]
- c) Calculate the flow depth using Sugio equation if the bed width is 3.0 m and flow discharge is $1.6\text{m}^3/\text{s}$. Assume the bed form is ripple. [6 Marks]

Attachment A

Yang's Method

$$\log Ct = 5.435 - 0.286 \log(Ws d_{50}/v) - 0.457 \log(U^*/Ws) + [1.799 - 0.409 \log(Ws d_{50}/v) - 0.314 \log(U^*/Ws)] \cdot \log[(Vs/Ws) - (VcS/Ws)]$$

For $1.15 < Re^* < 70$
 $Re^* = U^* d/v$
 $Vc/Ws = 2.5 / (\log(U^* d/v) - 0.06) + 0.66$
 $U^* = (gRS)^{1/2}$

For $Re^* \geq 70$
 $Vc/Ws = 2.05$

$$Cv \text{ (ppm)} = Ct \text{ (ppm)} / (\gamma_s / \gamma)$$

Ackers and White Equation

$$K = \frac{A_{gr} \left[11.3 \left(\frac{R}{d_{50}} \right)^{0.1} \right]^{1-n}}{\left(\frac{\lambda_s}{8} \right)^{n/2}}$$

$$\frac{V}{\sqrt{g \left(\frac{\gamma_s}{\gamma} - 1 \right) d_{50}}} = K \left(1 + J C_v^{1/m} \right)$$

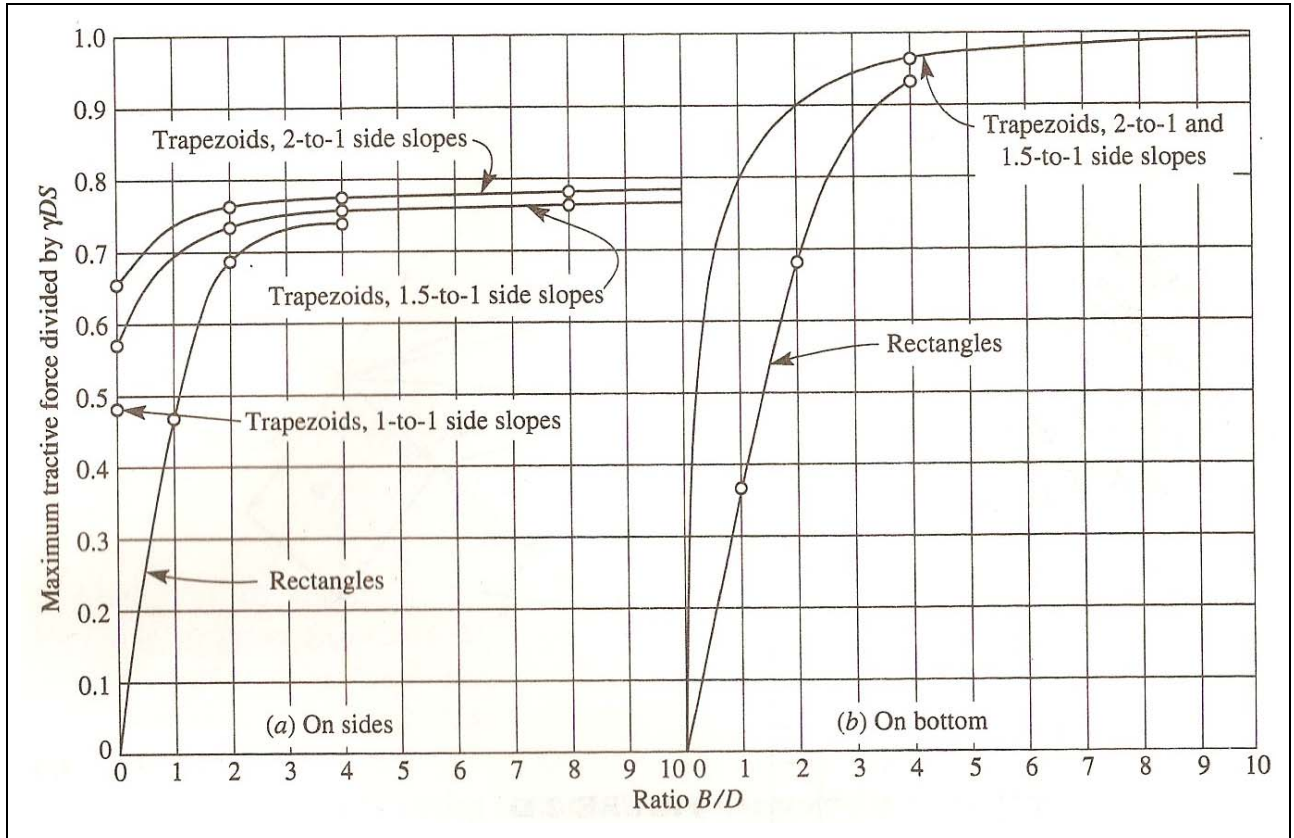
$$J = \left[\frac{\left(\frac{R}{d_{50}} \right) \left(\frac{A_{gr}}{BR} \right)^{1-n} \left(\frac{\lambda_s}{8} \right)^{n/2}}{C} \right]^{1/m}$$

$$D_{gr} = d_{50} \left[\frac{g \left(\frac{\gamma_s}{\gamma} - 1 \right)}{v^2} \right]^{1/3}$$

$$\lambda_s = \frac{8 g R S_o}{V^2}$$

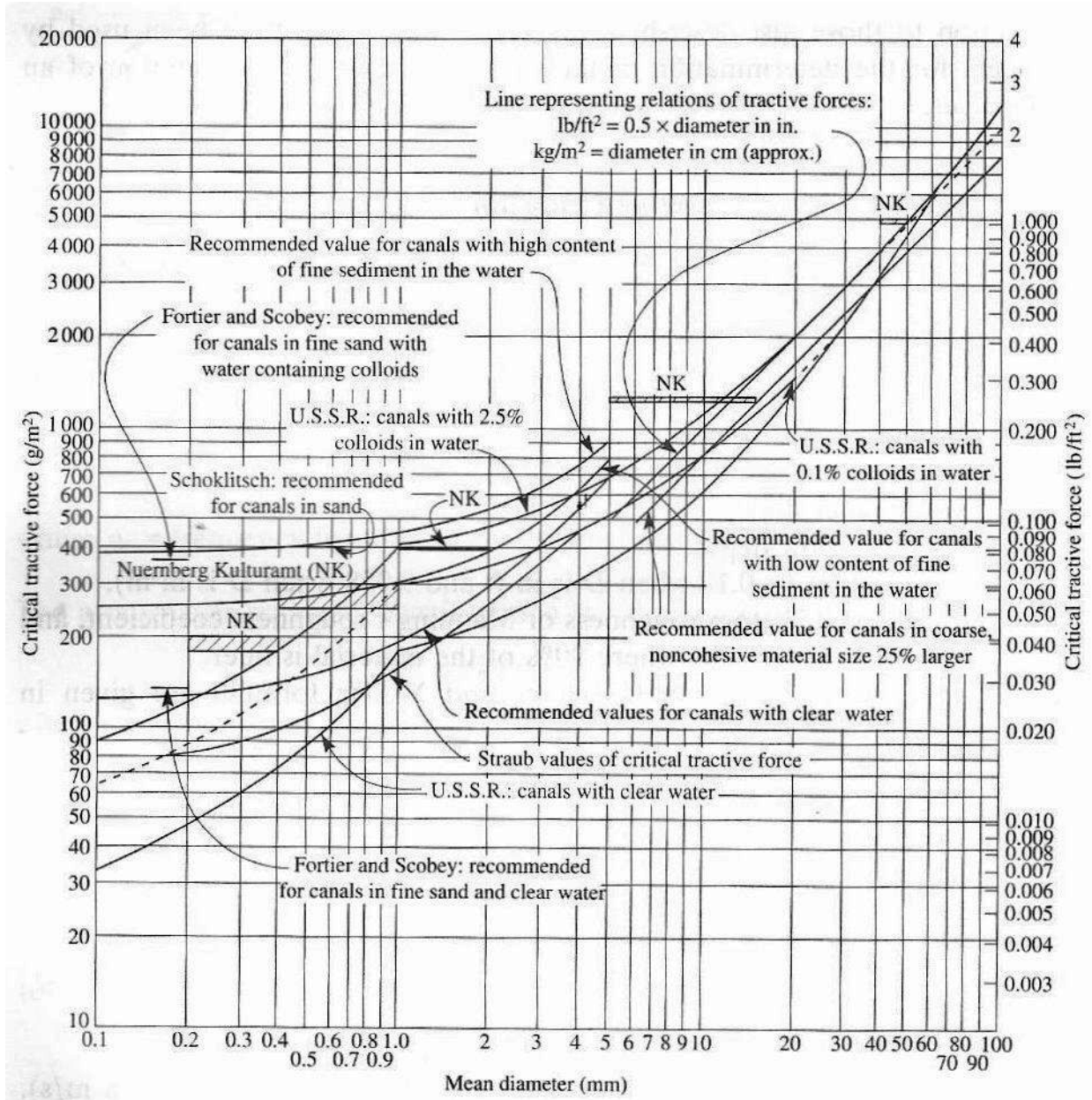
Coefficient	Fine	Transitional	Coarse
	$D_{gr} < 1.0$	$1.0 < D_{gr} < 60$	$D_{gr} > 60$
n	1.0	$n = 1.00 - 0.56 \log D_{gr}$	0.00
Agr	–	$Agr = 0.14 + 0.23 / \sqrt{(D_{gr})}$	0.17
m	–	$m = 1.34 + 9.66 / D_{gr}$	1.50
C		$\log C = 2.86 \log D_{gr} - (\log D_{gr})^2 - 3.53$	0.025

Attachment B



Maximum Shear Stress in a channel

Attachment C



Tractive force versus transportable sediment size)

(TERJEMAHAN)

1. a) Berikan ciri-ciri sebuah lompatan hidraulik.

[5 Markah]

b) Air mengalir pada kedalaman 2.5 m dalam sebuah saluran segiempat yang lebarnya 20.0 m. Cerun dasar adalah 0.001 dan $n = 0.030$. Kira halaju dan luahan bagi aliran seragam.

[5 Markah]

c) Tentukan jenis aliran dalam sebuah saluran trapezoid dengan lebar dasar 25.0 m, cerun sisi 1:1, dan kedalaman aliran seragam adalah 1.5 m. Cerun dasar adalah 0.001 dan $n = 0.030$.

[(5 Markah]

d) Rekabentuk sebuah saluran segiempat yang membawa luahan $50 \text{ m}^3/\text{s}$ dengan cerun dasar 0.001 dan $n = 0.030$.

[5 Markah]

2. Air yang mengalir dalam sebuah saluran lebar menghampiri sebuah bonggol yang tingginya 10 cm. Halaju aliran adalah 1.5 m/s pada kedalaman 1 m. Kira kedalaman aliran di atas bonggol.

[20 Markah]

3. Air mengalir keluar dari Takungan A melalui satu paip sepanjang 15 m yang menaik ke titik tertinggi di B, 1.5 m atas permukaan air di takungan A, dan mengalir terus keluar ke atmosfera di titik C, 4 m lebih rendah dari paras permukaan air di A. Panjang paip l_1 dari A ke B adalah 5 m dan panjang paip dari B ke C ialah 10 m. Kedua-dua pembukaan masuk dan keluar bagi paip adalah tajam dan nilai bagi f ialah 0.08. Kirakan:

(a) purata kelajuan air meninggalkan paip di C

[10 markah]

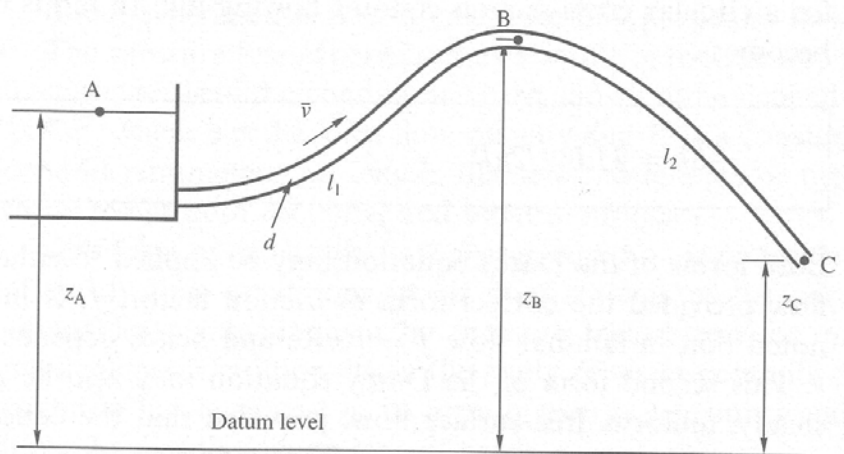
(b) tekanan di dalam paip di B

[10 markah]

...7/-

[EAH 225/3]

- 7 -



Rajah 1

4. Dua paip yang mempunyai sambungan tajam mempunyai diameter $d_1 = 50 \text{ mm}$, dan $d_2 = 100 \text{ mm}$, telah disambungkan dalam keadaan selari di antara dua takungan yang mempunyai perbezaan aras $h = 10 \text{ m}$. jika pemalar Darcy $f = 0.008$ bagi setiap paip, kirakan:

a) Kadar alir bagi setiap paip

[10 markah]

b) Diameter D bagi satu paip 100 m yang akan memberikan kadar alir yang sama sekiranya kedua-dua paip asal telah diganti dengan paip ini.

[10 markah]

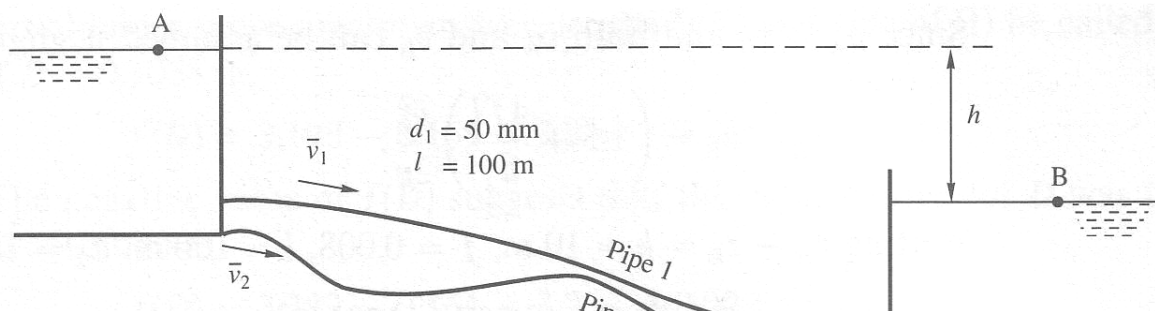


Figure 2

...8/-

[EAH 225/3]

- 8 -

5. a) Lord Rayleigh berminat dalam getaran yang terhasil daripada titisan berbentuk sfera berdiameter D yang dialirkan daripada lubang bulat. Apabila titisan berkenaan berubah bentuk daripada bentuk sfera kepada aliran bebas, titisan berkenaan bergetar pada tekanan permukaan σ dengan frekuensi f .

Sekiranya, $f =$ fungsi (σ, ρ, D, g), laksanakan analisis dimensi f .

[10 Markah]

- b) Satu model bergeometri untuk penskalaan 1:6 bagi satu pam centrifugal telah diujikan. Parameter awal adalah seperti berikut :

$N_p = 400$ rpm, $Q_p = 1.7$ m³/s , $H_p = 36.5$ m dan $P_p = 720$ KW.

Sekiranya model tersebut diujikan di bawah ketinggian air sebanyak 9m, tentukan kelajuan dan keluaran pada ketika model itu dilaksanakan serta kuasa yang diperlukan untuk melaksanakannya.

[10 Markah]

6. Data berikut telah dicerap dari Sungai Jelai berhampiran pekan Batu Kurau

Jadual 1

Keluasan Aliran	A	7.14	m ²
Radius Hidraulik	R	0.4	m
Halaju Purata	V	0.57	m/s
Kadar alir	Q	4.06	m ³ /s
Suhu	T	25.5	°C
Cerun Permukaan Aliran	S	0.002	
Lebar Dasar Saluran	B	20	m
Diameter min endapan	d_{50}	1.5	mm
Halaju jatuh	Ws	0.16	m/s

<i>Faktor Bentuk endapan</i>		0.7	
<i>Ketumpatan endapan</i>	ρ_s	2650	kg/m^3
<i>Ketumpatan air</i>	ρ	1000	kg/m^3
<i>Kelekitan Kinematik</i>	ν	1×10^{-6}	m^2/s

...9/-

[EAH 225/3]

- 9 -

Kira kepekatan jumlah bahan dasar menggunakan kaedah berikut:-

- a) *Persamaan Yang's equation* [8 Markah]
b) *Persamaan Ackers and White equation* [8 Markah]
c) *Persamaan Graf's equation* [4 Markah]

7. Sebuah saluran yang mempunyai ukuran berikut telah direkabentuk menggunakan pendekatan Tegasan Ricih Kritikal.

Jadual 2

<i>Kadar Alir Rekabentuk</i>	Q	1.6	m
<i>Kedalaman Aliran</i>	D	0.65	m
<i>Cerun Saluran</i>	S	0.0006	
<i>Angle of repose</i>	ϕ	36	$^{\circ}$
<i>Graviti</i>	g	9.81	m/s^2
<i>Berat Tentu Endapan</i>	S_s	2.65	
<i>Channel Side slope</i>		1.5	
<i>Manning number</i>	n	0.022	
<i>Mean Sediment diameter</i>	d_{50}	12	mm

- a) Kira Lebar dasar yang direkabentuk, B

[10 Markah]

- b) Kira kadar alir menggunakan persamaan Lacey sekiranya saluran segiempat tepat yang dibina mempunyai lebar dasar 3.0m dan kedalaman aliran 0.75m.

[4 Markah]

c) Kira kedalaman aliran menggunakan persamaan Sugio sekiranya lebar dasar adalah 3.0 m dan kadar alir $1.6 \text{ m}^3/\text{s}$. Andaikan bentuk dasar ialah riak.

[6 Markah]

oooOOooo