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]

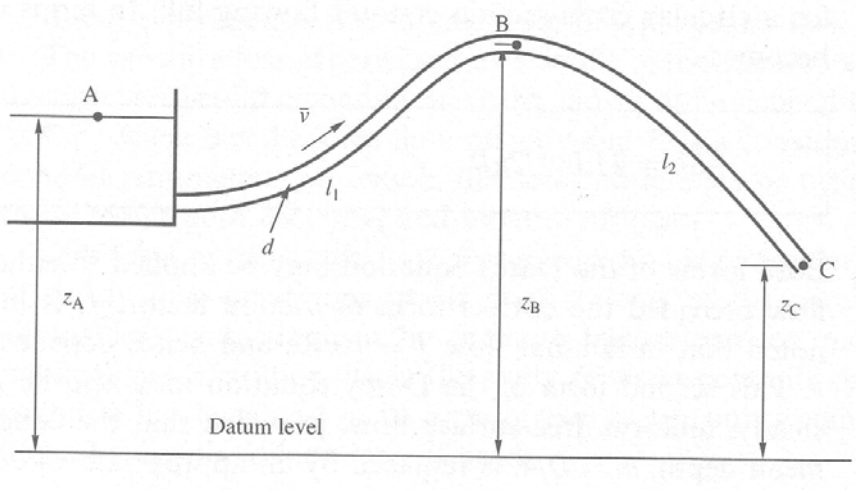

Figure 1

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]

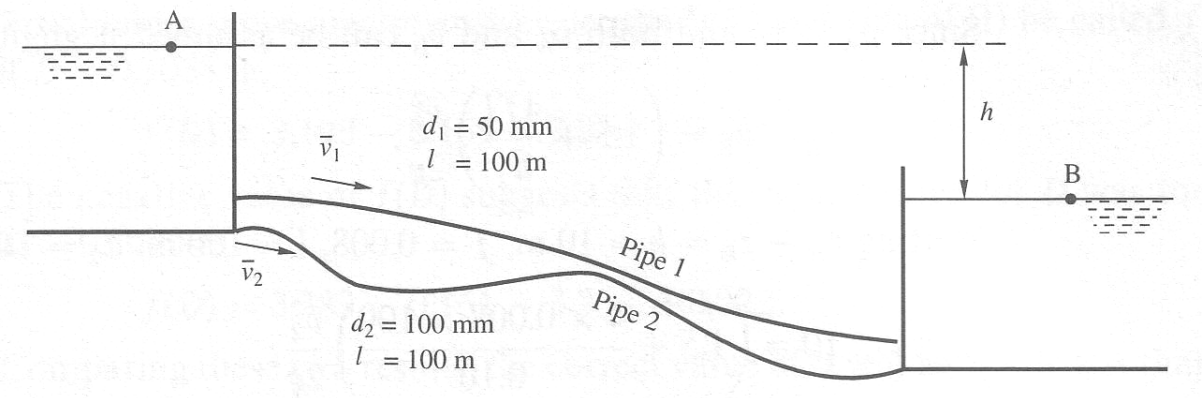

Figure 2

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 m^3/s, Hp=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	^oC
Surface Slope	S	0.002	
Channel bed width	B	20	m
Mean sediment diameter	d_{50}	1.5	mm
Fall velocity,	Ws	0.16	m/s
Sediment shape factor		0.7	
Sediment Density,	ρs	2650	kg/m^3
Water Density,	ρ	1000	kg/m^3
Kinematic viscosity,	ν	$1x10^{-6}$	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	^{o}
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 wit 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 $1.6m^3/s$. Assume the bed form is ripple.

[6 Marks]

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Attachment A

Yang's Method

$$\log Ct = 5.435-0.286\log(Wsd_{50}/\nu)-0.457\log(U_*/Ws) +[1.799- 0.409\log(Wsd_{50}/\nu)-0.314\log(U_*/Ws)] *\log[(VS/Ws)-(VcS/Ws)]$$

For $1.15 < Re^* < 70$

$Re^*=U_*d/\nu$

$Vc/Ws = 2.5/(\log(U_*d/\nu)-0.06) + 0.66$

$U_* = (gRS)^{1/2}$

For $Re^* \geq 70$

$Vc/Ws = 2.05$

$Cv\ (ppm) = Ct(ppm)/(\gamma s/\gamma)$

Ackers and White Equation

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

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

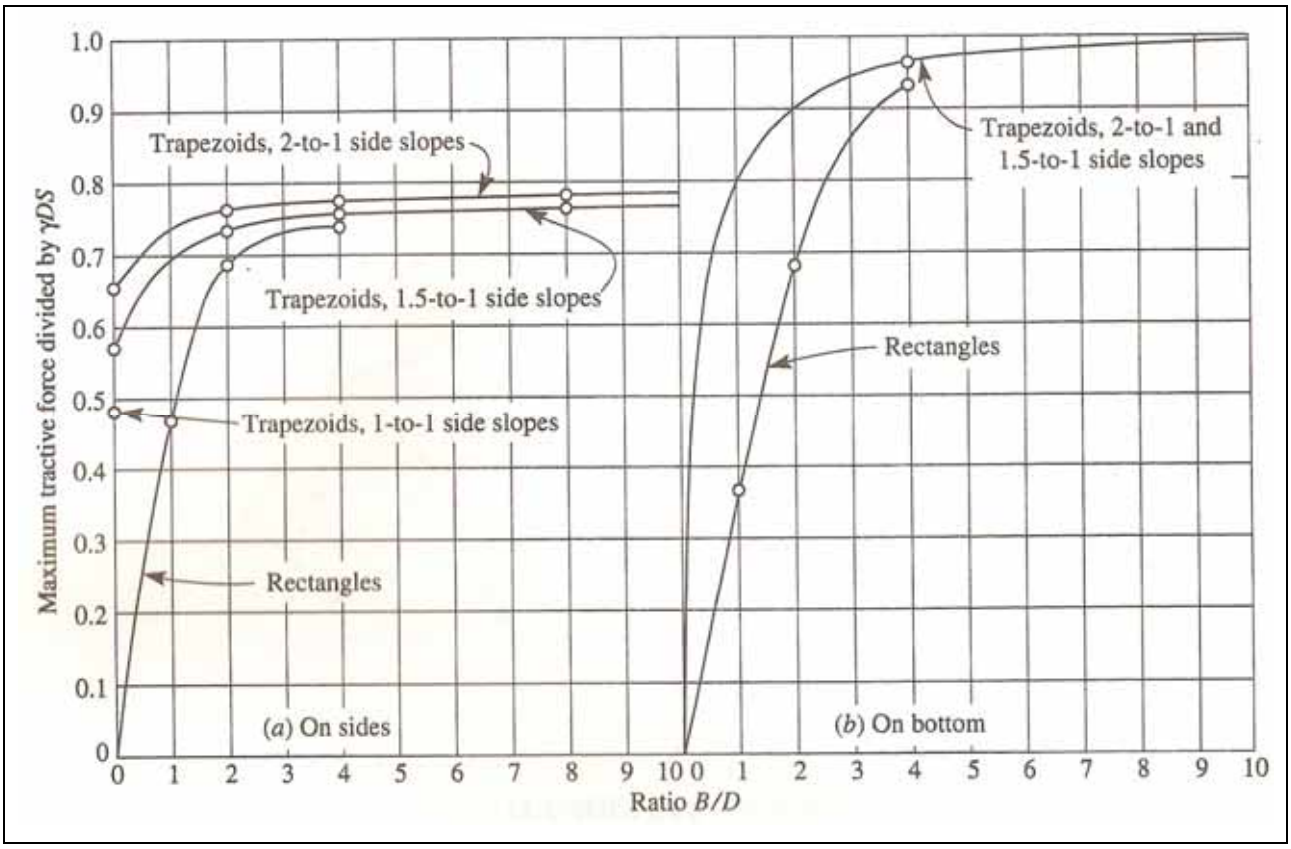
$$J = \left[\frac{\left(\frac{R}{d_{50}}\right)\left(\frac{A_{gr}}{BR}\right)^{1-n}\left(\frac{\lambda_s}{8}\right)^{n/2}}{C}\right]^{1/m}$$

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

$$\lambda s = \frac{8gRSo}{V^2}$$

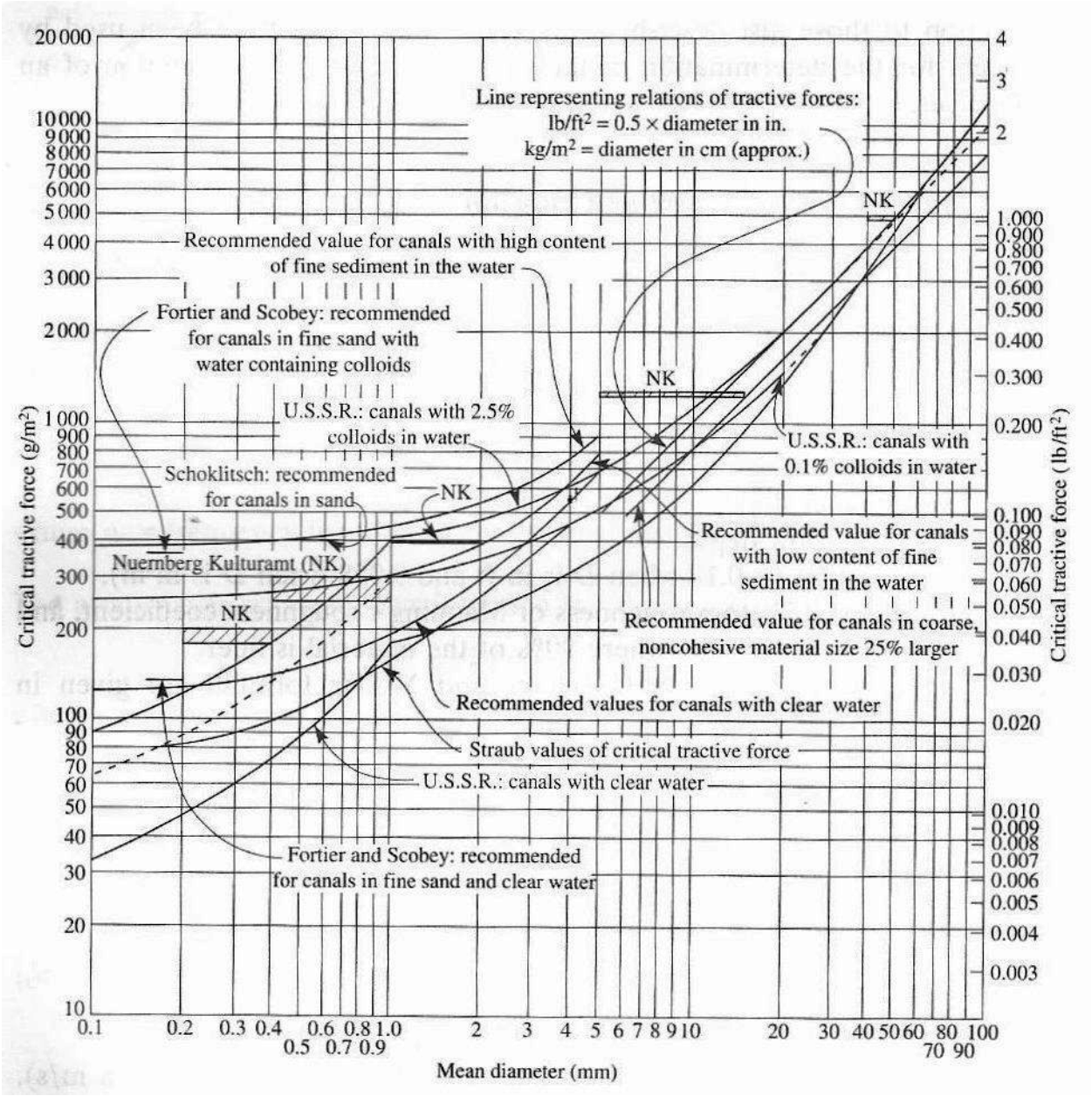
Coefficient	Fine	Transitional	Coarse
	$D_{gr} < 1.0$	$1.0 < D_{gr} < 60$	$D_{gr} > 60$
n	1.0	$n = 1.00 - 0.56 \log D_{gr}$	0.00
Agr	–	$Agr = 0.14 + 0.23/\sqrt{(D_{gr})}$	0.17
m	–	$m = 1.34 + 9.66/D_{gr}$	1.50
C		$\log C = 2.86 \log D_{gr} - (\log D_{gr})^2 - 3.53$	0.025

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 m^3/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]

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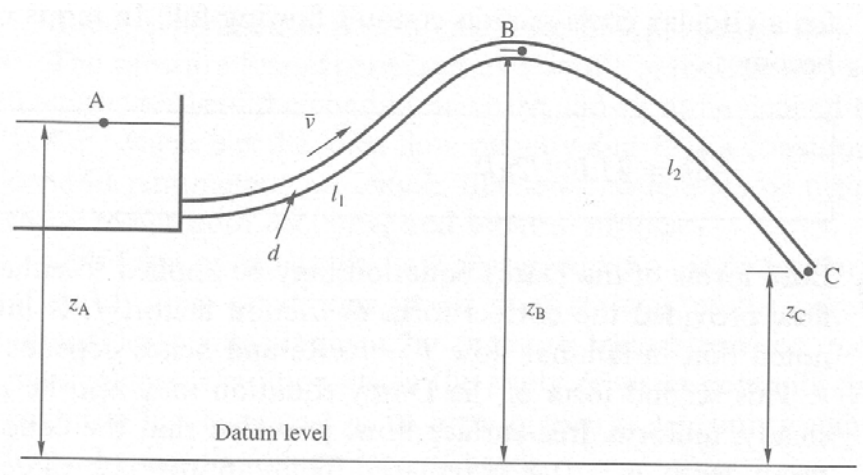

Rajah 1

4. *Dua paip yang mempunyai sambungan tajam mempunyai diameter d_1 = 50 mm, dan d_2 = 100 mm, telah sisambungkan dalam keadaan selari di antara dua takungan yang mempunyai perbezaan aras h = 10 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 talah diganti dengan paip ini.*

[10 markah]

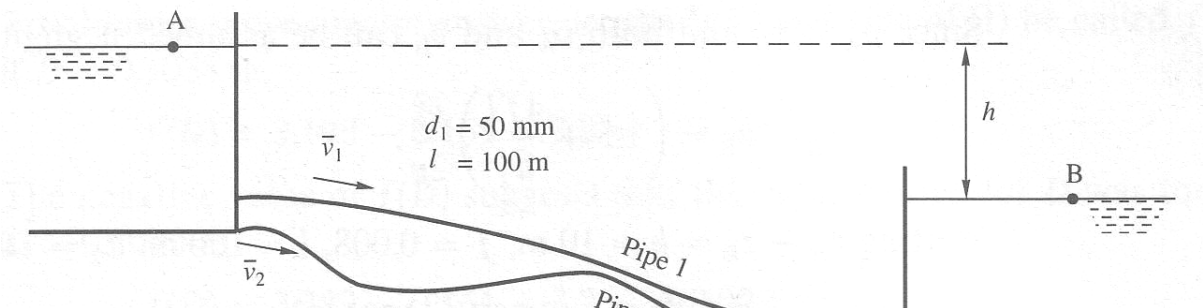

Figure 2

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 analisi 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* m^3/s *, Hp=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*
Kadaralir	*Q*	*4.06*	m^3/s
Suhu	*T*	*25.5*	^oC
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*

Faktor Bentuk endapan		*0.7*	
Ketumpatan endapan	ρs	*2650*	kg/m^3
Ketumpatan air	ρ	*1000*	kg/m^3
Kelekitan Kinematik	v	$1x10^{-6}$	m^2/s

...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

Kadaralir Rekabentuk	Q	*1.6*	*m*
Kedalaman Aliran	D	*0.65*	*m*
Cerun Saluran	S	*0.0006*	
Angle of repose	ϕ	*36*	^{o}
Graviti	g	*9.81*	m/s^2
Berat Tentu Endapan	Ss	*2.65*	
Channel Side slope		*1.5*	
Manning number	n	*0.022*	
Mean Sediment diameter	d_{50}	*12*	*mm*

a) *Kira Lebar dasar yang direkabentuk, B*

[10 Markah]

b) *Kira kadaralir 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 kadaralir 1.6 m^3/s. Andaikan bentuk dasar ialah riak.*

[6 Markah]

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