UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2011/2012 Academic Session

June 2012

EAH 225/3 – Hydraulics
[*Hidraulik*]

Duration : 3 hours
[*Masa : 3 jam*]

Please check that this examination paper consists of **FIFTEEN (15)** pages of printed material including 2 appendices before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi **LIMA BELAS (15)** muka surat yang bercetak termasuk 2 lampiran sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions.
[***Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan.*

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*].

In the event of any discrepancies, the English version shall be used.
[*Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai*].

1. (a) A rectangular canal is to be excavated in soil and lined with coarse gravel (n = 0.025). The canal is to be designed for a discharge of 6 m^3/s, and it will have a slope of 0.0016. Calculate the cross sectional area and hydraulic radius for the canal if it is to be designed so that erosion of the canal will not occur at a maximum velocity of 1.5 m/s? Choose a canal cross section that will satisfy the limitations.

[10 marks]

(b) A 3 m wide rectangular channel carries a discharge of 15 m^3/s at a uniform depth of 1.7 m. If the Manning's coefficient (n) is 0.022, calculate:

(i) channel slope

[4 marks]

(ii) critical depth

[3 marks]

(iii) Froude number

[3 marks]

2. (a) Lord Rayleigh was interested in the vibration of a spherical drop of diameter *D* which is formed when liquid issues from a circular orifice. When the drop is slightly deformed from its spherical shape and left free, on account of surface tention σ it vibrated about its position of equilibrium with frequency *f*. If determine the dimensional analysis for *f*.

$$f = \Phi(\sigma, \rho, D, g)$$

[10 marks]

(b) A river carries a discharge of 16 000 m^3/s at 8.0 m depth and 0.0025 slope when its width is 400 m. About 15 km reach of the river is to be reproduced in the laboratory where 30 m space and a maximum of 0.2 m^3/s discharge are available. Determine the horizontal and vertical scales, model slope and roughness scale.

[10 marks]

3. Paya Town is a flood prone area. One of the proposals to alleviate the problem is by straightening the Kayu River from Point A to Point C (**Figure 1**).

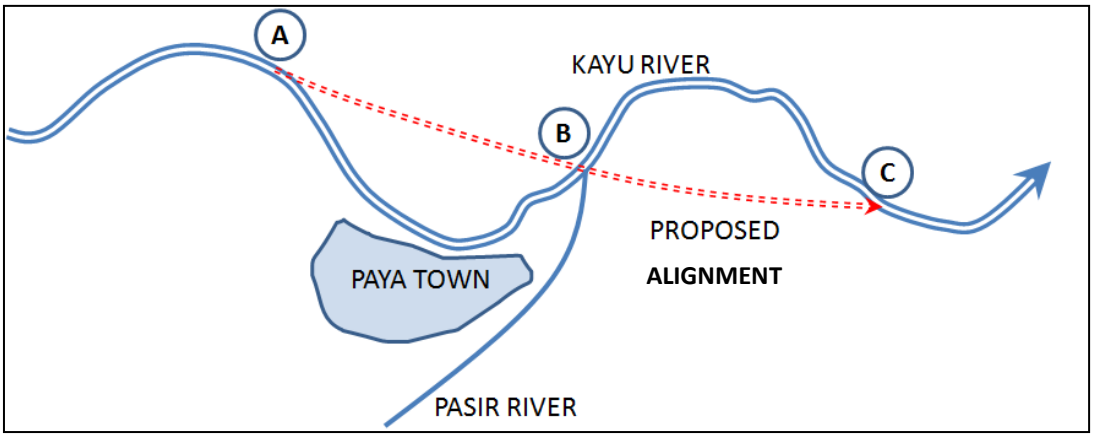


Figure 1

A summary of the proposal is as shown in **Table 1.**

Table 1

No	Description	Existing Condition	Proposal
1.	Distance from Point A to Point B	5 km	3 km
2.	Distance from Point B to Point C	5 km	3 km
3.	River Bed level at Point A	111 m	111 m
4.	River Bed level at Point C	106 m	106 m
5.	Cross section shape	Rectangular with 10 m bed width	Rectangular with 10 m bed width
6.	Design Discharge	50 m^3/s	50 m^3/s
7.	Manning's Coefficient	0.03	0.03

(a) Predict qualitatively the effect on the modified Kayu River reach with the aid of sketches.

[5 marks]

(b) Predict qualitatively the effect of Kayu River straightening works to Pasir River with the aid of sketches.

[5 marks]

(c) Determine the design flow depth using equation for the modified channel.

[6 marks]

(d) Determine the minimum armour size to ensure no bed erosion at Point B.

[4 marks]

4. A 18 m wide rectangular channel carries water with a mean depth of 1.1 m and slope of 0.00005 carrying flow discharge 22.5 m^3/s. The mean diameter of the bed material is 0.60 mm and the sediment fall velocity is 7 cm/s.

(a) Prove that the bed is not stable

[2 marks]

(b) Determine the bed form using the Shields diagram,

[5 marks]

(c) Calculate the sediment discharge using :

(i) Graf Equation

[5 marks]

(ii) Yang Equation

[8 marks]

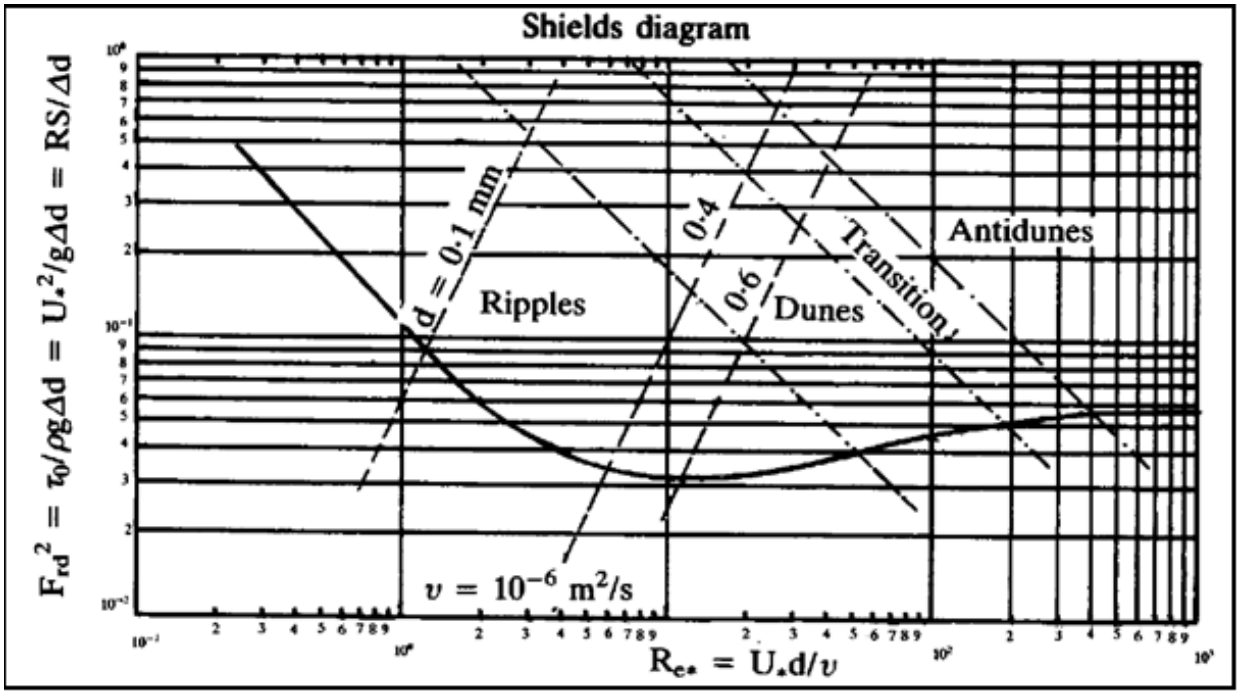


Figure 2 : Shields Diagram

Note:

Water density (kg/m^3)	ρ =	1000
Sediment density (kg/m^3)	ρ_s =	2650
Gravity Acceleration (m/s^2)	g =	9.81
Kanametic Viscosity (m^2/s)	ν =	0.000001

Yang's Equation

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

$Cv\ (ppm) = Ct(ppm)/Ss$

For $Re^* = 1.15$ to 70

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

For $Re^* > 70$

$Vc/Ws = 2.05$

5. (a) In **Figure 3**, an open air elevated tank is delivered water to a building which is located 20 m higher than the ground surface at the tank. The required flow rate is 0.15 m^3/s with 20 kN/m^2 pressure at the building. The connecting pipe line is 250 m long and 25 cm in diameter. The head loss through the pipe is 7.5 m. Determine the elevation of the water surface (z_1).

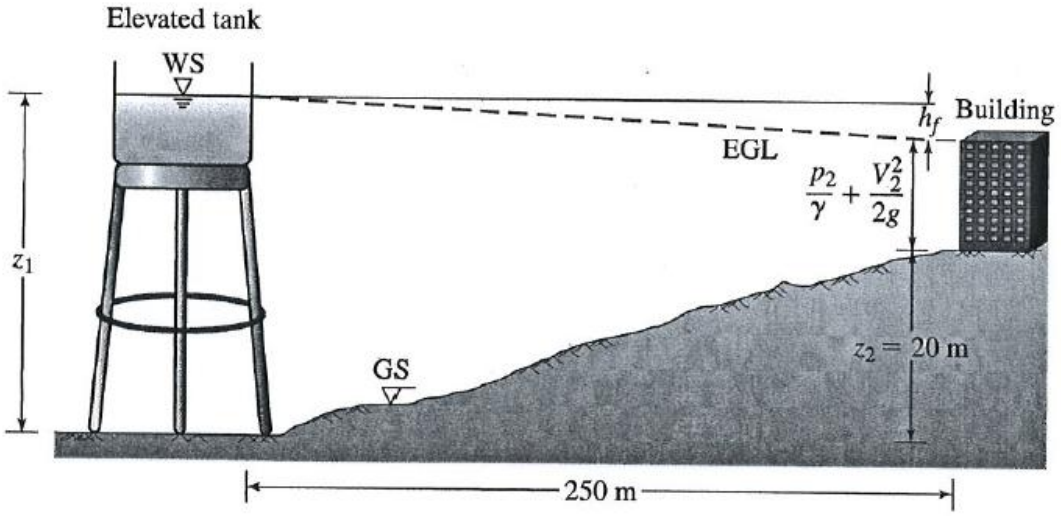


Figure 3

[8 marks]

(b) Two pipes are laid in parallel as shown in **Figure 4**. All pipe characteristics and dimensions are also shown in **Figure 4**. If the total discharge is $0.35 m^3/s$ and the water temperature is 25^oC, determine be the discharge in each line.

Given : Kinematics Viscosity (ν) at 25^oC is $0.893 \times 10^{-6} m^2/s$

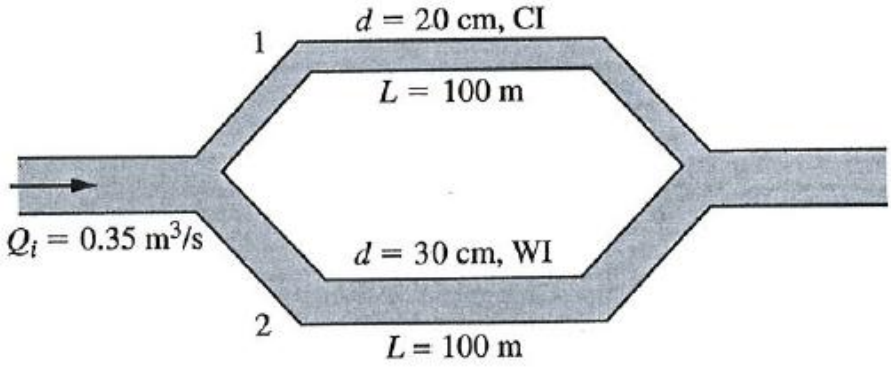


Figure 4

[12 marks]

6. (a) A pump is used to deliver a discharge of $0.05 m^3/s$ from a river to a storage reservoir as shown in **Figure 5**. The piping system consists of 500 m of 0.15m cast iron with 90^o bend and then transition to a 0.1 m cast iron pipe 100m long. The difference water level in the river and the reservoir is 20 m. Determine the power of pump required to discharge water through a fully open gate valve. Assume the water temperature is 20^oC.

Given : Kinematics Viscosity (ν) at 20^oC is $1.003 \times 10^{-6} m^2/s$, Power = $\gamma Q h_p$

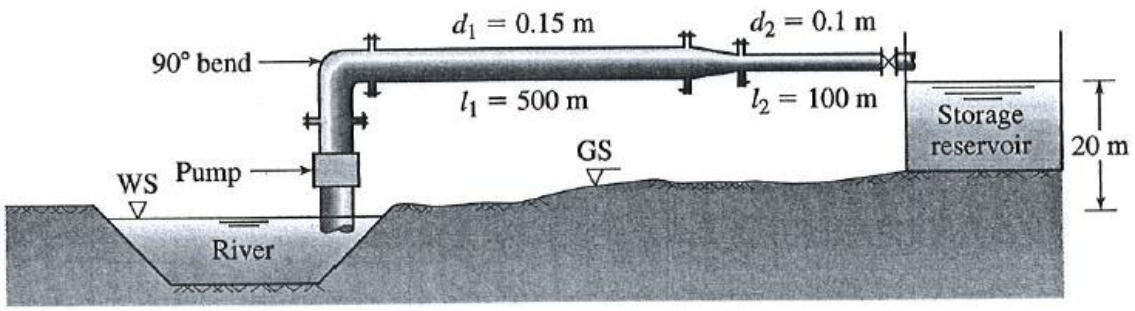


Figure 5

[15 marks]

(b) Describe briefly the differences :

(i) the head lossess and discharges when the pipes are laid in series and parallel .

(ii) the pump discharges and heads when two pumps are operated in series and parallel.

[5 marks]

1. (a) *Sebuah saluran pengairan berbentuk segiempat akan diperbuat dari tanah dan dilitupi batu kerikil kasar (n = 0.025). Saluran tersebut akan membawa luahan 6 m³/s pada cerun 0.0016. Kira nilai keratan rentas dan jejari hidraulik jika saluran tersebut direkabentuk untuk mengelak hakisan pada halaju maksimum 1.5 m/s? Tentukan saiz keratan rentas saluran yang menepati kriteria yang ditetapkan.*

[10 markah]

(b) *Sebuah saluran segiempat dengan lebar 3 m membawa luahan 15 m³/s pada kedalaman seragam 1.7 m. Jika pekali kekasaran Manning n=0.022, kira*

(i) cerun saluran

[4 markah]

(ii) kedalaman kritikal

[3 markah]

(iii) Nombor Froude

[3 markah]

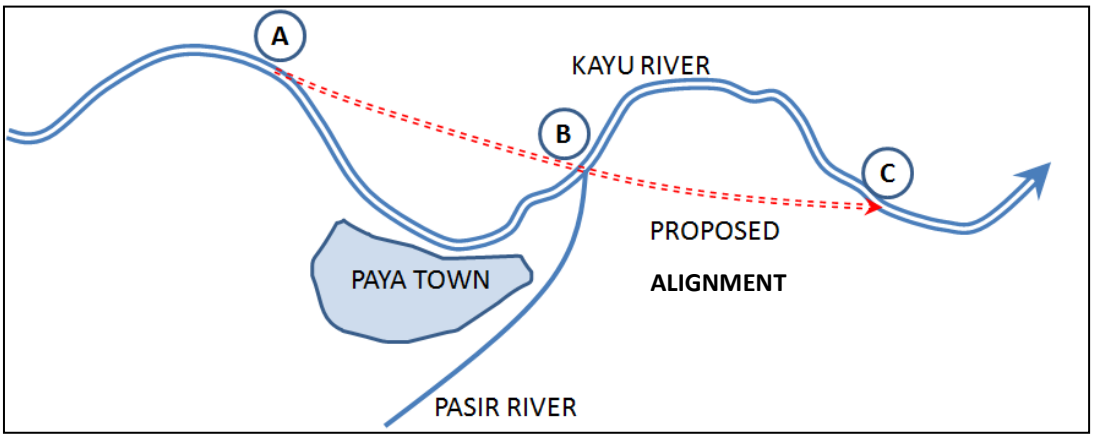
2. (a) *Lord Rayleigh berminat dalam getaran yang terhasil daripada titisan berbentuk sfera berdiameter D yang dialirkan daripada lubang bulat. Apabila titisan berkenaan berubah bentuk daripada sfera kepada aliran bebas, titisan berkenaan bergetar pada tekanan permukaan* σ *dengan frekuensi f. Sekiranya f = fungsi* (σ, ρ, *D*, g), *laksanakan analisis dimensi f.*

[10 markah]

(b) *Sebatang sungai selebar 400m dengan kedalaman 8.0 m dan kecerunan 0.0025 mengalirkan air pada kadar 16000 m³/s. Sebuah model sungai sepanjang 15km akan dibina di makmal dengan had ruangan 30m dan kadar alir maksimum hanya 0.2 m³/s dibenarkan. Tentukan skala melintang dan menegak, model kecerunan dan skala kekasaran bagi model tersebut.*

[10 markah]

3. *Bandar Paya adalah satu kawasan yang terdedah kepada banjir. Salah satu cadangan untuk menyelesaikan masalah ini adalah dengan meluruskan Sungai Kayu dari Titik A ke Titik C (**Rajah 1**).*



Rajah 1

Ringkasan cadangan dirumuskan dalam ***Jadual 1****.*

Jadual 1

Bil	*Keterangan*	*Keadaan Semasa*	*Cadangan*
1.	*Jarak antara Titik A ke Titik B*	*5 km*	*3 km*
2.	*Jarak antara Titik B ke Titik C*	*5 km*	*3 km*
3.	*Paras dasar sungai di Titik A*	*111 m*	*111 m*
4.	*Paras dasar sungai di Titik C*	*106 m*	*106 m*
5.	*Bentuk keratan rentas*	*Segi empat dengan lebar dasar 10 m*	*Segi empat dengan lebar dasar 10 m*
6.	*Kadaralir Rekabentuk*	*50 m^3/s*	*50 m^3/s*
7.	*Pekali Manning*	*0.03*	*0.03*

(a) *Berbentuk lakaran, ramal secara kuantitatif kesan kepada ruas Sungai Kayu yang diubahsuai.*

[5 markah]

(b) *Dengan bantuan lakaran, ramal secara kuantitatif kesan meluruskan Sungai Kayu kepada Sungai Pasir.*

[5 markah]

(c) *Tentukan kedalaman aliran rekabentuk untuk saluran yang diubahsuai menggunakan Persamaan Lacey.*

[6 markah]

(d) *Tentukan saiz minimum batu perlindungan bagi memastikan tiada hakisan kepada dasar sungai di Titik B.*

[4 markah]

4. *Sebuah saluran segi empat tepat berukuran 18 m lebar menyalirkan air pada kedalaman 1.1 m dan cerun dasar 0.00005 dan menyalirkan air 22.5 m^3/s . Diameter min bahan dasar adalah 0.06 mm dan halaju jatuh adalah 7 sm/s.*

(a) Buktikan dasar saluran tidak stabil.

[2 markah]

(b) Tentukan bentuk dasar dengan menggunakan Rajah Shield.

[5 markah]

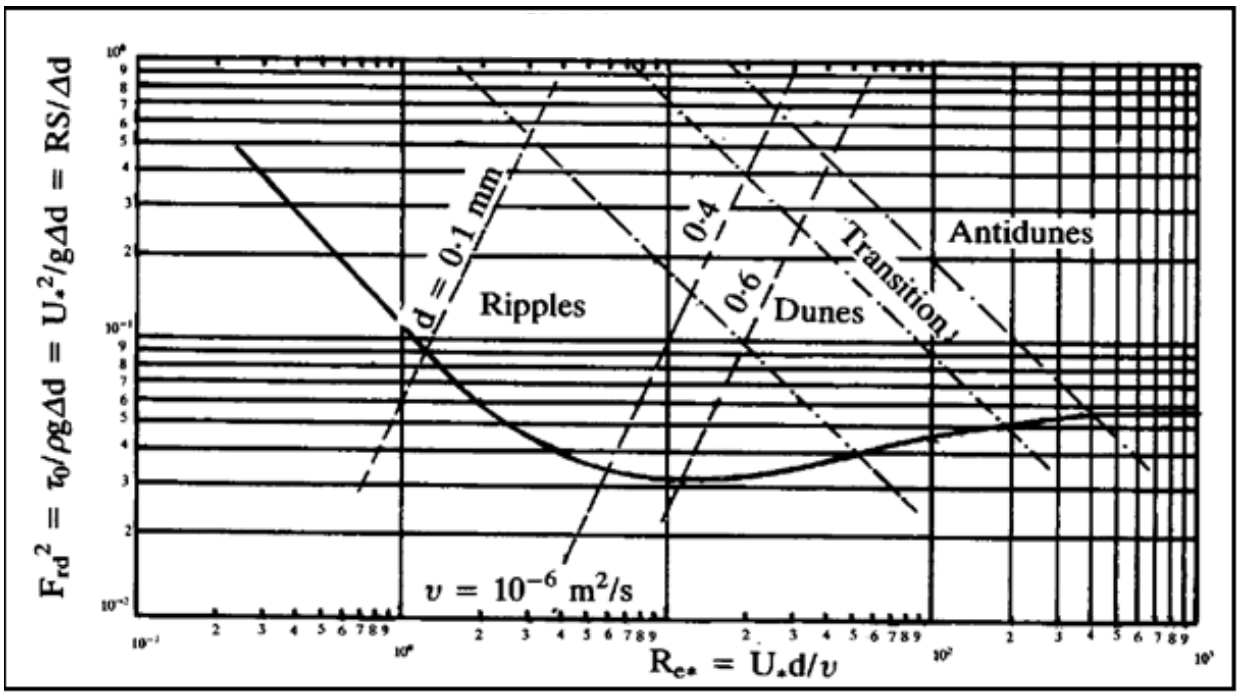
(c) Kira luahan endapan menggunakan :

(i) Persamaan Graf

[5 markah]

(ii) Persamaan Yang

[8 markah]



Rajah 2 : *Gambarajah Shields*

Nota :

Water density (kg/m^3)	ρ =	*1000*
Sediment density (kg/m^3)	ρ_s =	*2650*
Gravity Acceleration (m/s^2)	*g* =	*9.81*
Kanametic Viscosity (m^2/s)	υ =	*0.000001*

Yang's Equation

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

$$Cv\ (ppm) = Ct(ppm)/Ss$$

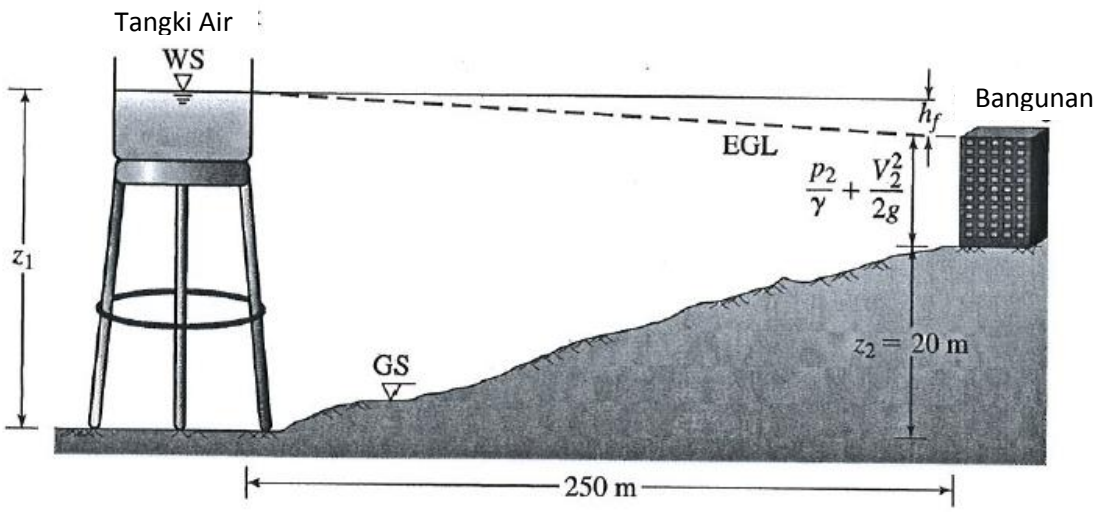
For $Re^* = 1.15$ *to* 70

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

For $Re^* > 70$

$$Vc/Ws = 2.05$$

5. *(a)* *Dalam di* ***Rajah 3****, sebuah tangki air terbuka mengalirkan air ke sebuah bangunan yang terletak 20m tinggi dari aras tanah tersebut. Keperluan kadar alir adalah* $0.15m^3/s$ *dan mempunyai tekanan* $20kN/m^2$*. Paip sambungan antara keduanya adalah 250m panjang dan bergarispusat 25sm. Didapati kehilangan turus paip adalah 7.5m. Tentukan ketinggian paras air dalam tangki* (z_1) *tersebut.*

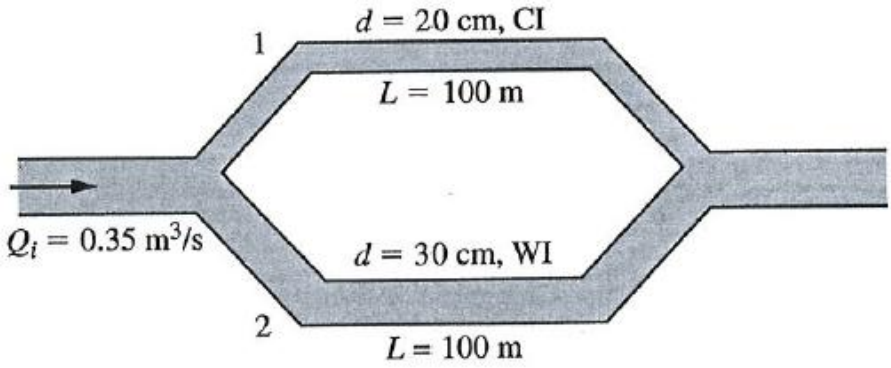


Rajah 3

[8 markah]

(b) *Dua batang paip bersiri mempunyai ciri-ciri dan dimensi yang ditunjukkan dalam* ***Rajah 4****. Sekiranya kadar alir adalah 0.35m^3/s dan suhu air adalah 25^{o}C, tentukan nilai kadar alir bagi setiap paip.*

Nota : ν at 25^{o}C is 0.893x10^{-6} m^3/s

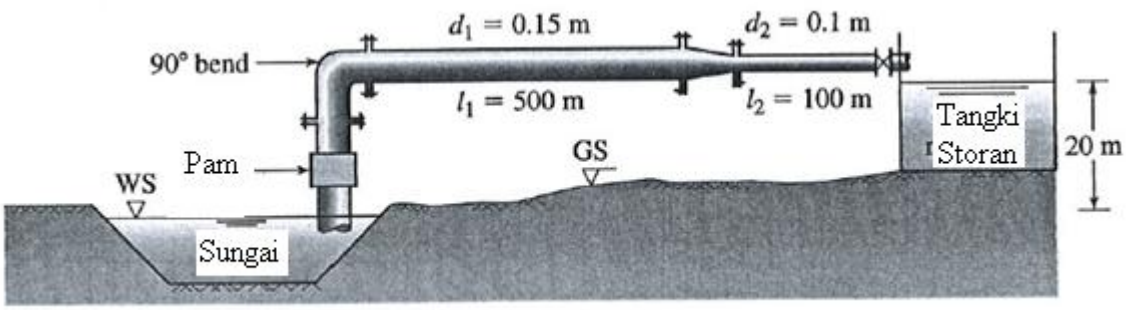


Rajah 4

[12 markah]

6. (a) *Sebuah pam digunakan untuk menghantar 0.05 m³/s air dari sebatang sungai ke storan reservor seperti yang ditunjukkan dalam* ***Rajah 5****. Sistem pepaipan mempunyai 500 m paip besi tetulang yang berdiameter 0.15 m kemudian mengucup ke paip berdiameter 0.1 m paip besi tetulang yang panjangnya 100 m. Perbezaan paras air di permukaan sungai dan tangki storan reservor adalah 20 m. Tentukan nilai kuasa yang diperlukan untuk mengalirkan air melalui pintu valve terbuka sepenuhnya. Andaikan suhu air adalah 10^{o}C.*

Nota : ν at 20^{o}C is 1.003x10^{-6} m³/s , Power = γQh_p



Rajah 5

[15 markah]

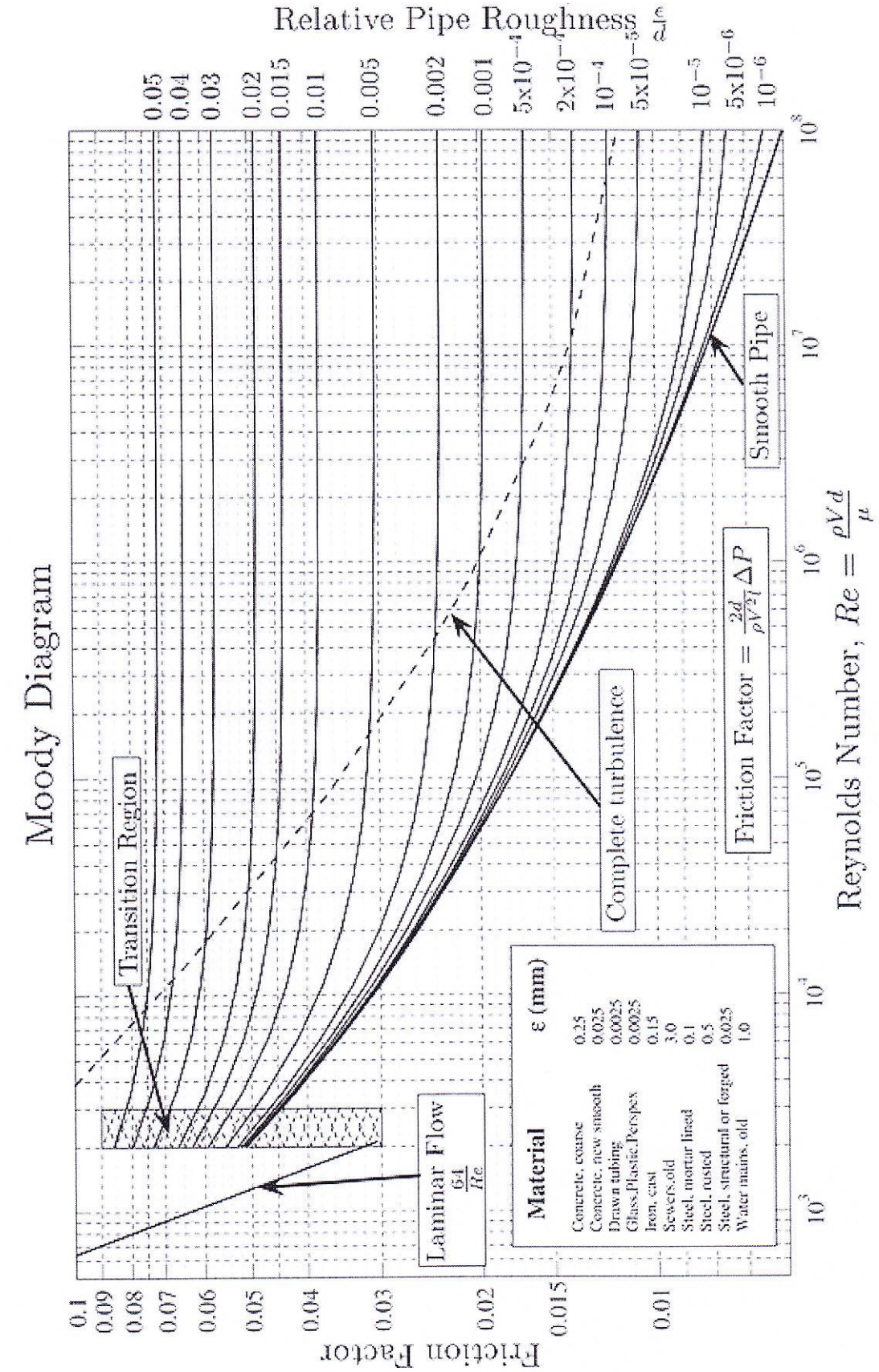
(b) Terangkan dengan ringkas perbezaan :

(i) kehilangan turus dan kadar alir apabila paip diaturkan secara bersiri dan selari

(ii) kadar alir dan turus pam apabila dua buah pam beroperasi secara selari dan bersiri.

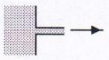
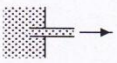
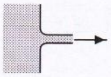
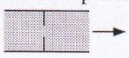
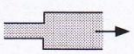
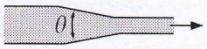
[5 markah]

Appendix 1
Lampiran 1



Appendix 2
Lampiran 2

Table 7.2 Minor Loss Coefficients K for Selected Devices*

Type of fitting		Screwed			Flanged	
Diameter	2.5 cm	5 cm	10 cm	5 cm	10 cm	20 cm
Globe value (fully open)	8.2	6.9	5.7	8.5	6.0	5.8
(half open)	20	17	14	21	15	14
(one-quarter open)	57	48	40	60	42	41
Angle valve (fully open)	4.7	2.0	1.0	2.4	2.0	2.0
Swing check valve (fully open)	2.9	2.1	2.0	2.0	2.0	2.0
Gate valve (fully open)	0.24	0.16	0.11	0.35	0.16	0.07
Return bend	1.5	0.95	0.64	0.35	0.30	0.25
Tee (branch)	1.8	1.4	1.1	0.80	0.64	0.58
Tee (line)	0.9	0.9	0.9	0.19	0.14	0.10
Standard elbow	1.5	0.95	0.64	0.39	0.30	0.26
Long sweep elbow	0.72	0.41	0.23	0.30	0.19	0.15
45° elbow	0.32	0.30	0.29			
Square-edged entrance 			0.5			
Reentrant entrance 			0.8			
Well-rounded entrance 			0.03			
Pipe exit			1.0			
	Area ratio					
Sudden contraction† 	2:1		0.25			
	5:1		0.41			
	10:1		0.46			
	Area ratio A/A_0					
Orifice plate 	1.5:1		0.85			
	2:1		3.4			
	4:1		29			
	≥6:1		$2.78\left(\frac{A}{A_0}-0.6\right)^2$			
Sudden enlargement‡ 			$\left(1-\frac{A_1}{A_2}\right)^2$			
90° miter bend (without vanes) 			1.1			
(with vanes) 			0.2			
General contraction	(30° included anlge)		0.02			
	(70° included angle)		0.07			

* Values for other geometries can be found in *Technical Paper 410*. The Crane Company, 1957.
† Based on exit velocity V_2.
‡ Based on entrance velocity V_1.

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