UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2010/2011 Academic Session

April/May 2011

EAH 225/3 – Hydraulics
[*Hidraulik*]

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

Please check that this examination paper consists of **FOURTEEN (14)** pages of printed material including appendices before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi **EMPAT BELAS (14)** muka surat yang bercetak termasuk 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. Consider a wide stream with flow depth of 2.0 m, bed slope of 0.002, and the median grain size of channel bed is 5 mm. Calculate:

   (a) Shear velocity

   [3 marks]

   (b) Bed shear stress

   [3 marks]

   (c) Prove that the stream bed is not stable

   [6 marks]

   (d) Determine the minimum particle size to prevent the bed load motion for fully-rough turbulent flow.

   [5 marks]

   (e) List two applications of the Incipient of sediment motion

   [4 marks]

Assume:

Water density	=	1000 kg/m^3
Sediment density, ρs	=	2650 kg/m^3
Kinematic viscosity, ν	=	0.000001 m^2/s
Gravity acceleration, g	=	9.80 m/s^2

Figure 1 Shield Diagram

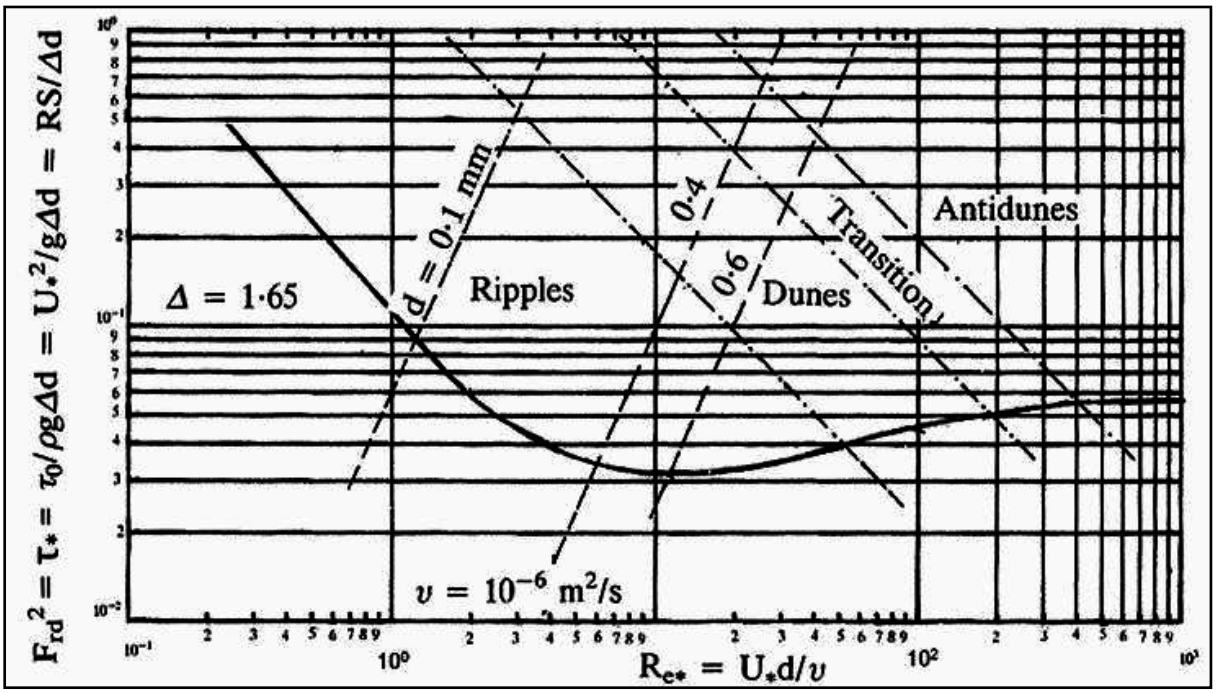


Figure 1: Shield Diagram

2. A 25 m rectangular channel has a bed slope of 0.0009. The bed consist of a mixture of light particles (ρs = 2350 kg/m^3) with a median particle size d_{50} = 1.15mm and fall velocity of 0.15 m/s. The flow rate is 7.9 m^3/s (assume to be constant) and flow depth is 2.5 m.

(a) Calculate the sediment transport rate using

(i) Meyer-Peter-Muller(MPM) Equation

[5 marks]

(ii) Einstein - Brown(EB) Equation

[3 marks]

(b) If a reservoir having a capacity of 20 x 10^6 m^3 is to be constructed, estimate the life of the reservoir based on MPM equation.

[2 marks]

(c) Briefly describe five (5) effects resulting from dam construction.

[10 marks]

Assume:

Water density, ρ =	1000	kg/m^3
Kinematic viscosity, ν =	0.000001	m^2/s
Gravity acceleration, g =	9.80	m/s^2

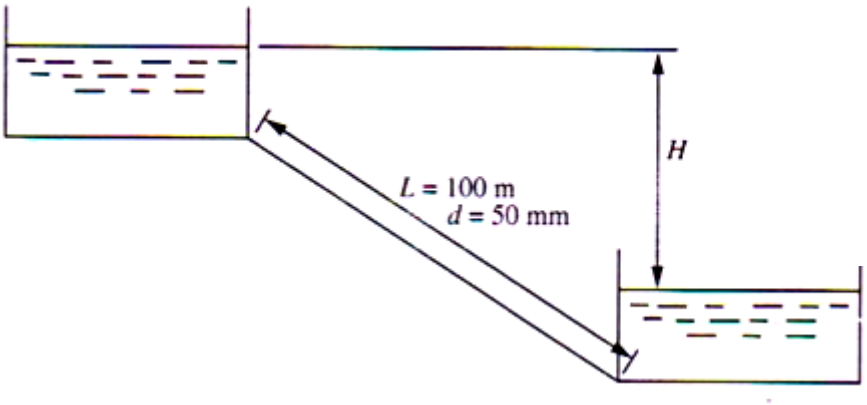


Figure 2

3. (a) Two ethanol storage tanks are connected by 100m of straight pipe as shown in figure 2. Both tanks are open to atmosphere and the connecting pipe has an inside diameter of 50mm and relative roughness (k/D) of 0.002. Determine the pressure drop over the length of pipe if the flow rate is $15m^3/hr$ and estimate the difference in level of the two tanks.

Assume the density of ethanol is $780kg/m^3$ and its viscosity is $1.7x10^{-3}$ Ns/m^2

[8 marks]

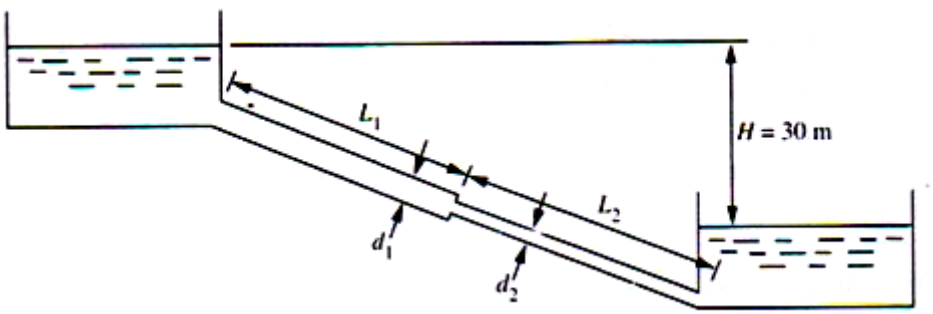


Figure 3

(b) Two reservoirs are connected by a straight pipe 1 km long. For the first half of its length the pipe is 12 cm in diameter and then it is suddenly reduce to 6 cm as figure 3. Determine the flow through the pipe if the surface of the water in the upper reservoir is 30 m above than in the lower. Assume a friction factor of 0.005 for both pipes.

[12 marks]

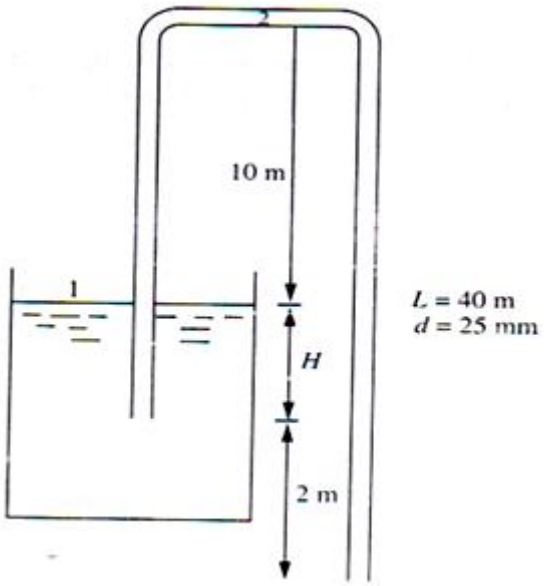


Figure 4

4. (a) A liquid of density $1.7x10^{-3}$ Ns/m^2 is siphoned using a tube of internal diameter 25mm and length 40m as figure 4. Determine the flow rate of the siphone. . Assume the friction factor of 0.005 and the minimum allowable pressure of the liquid is $18kN/m^2$.

[8 marks]

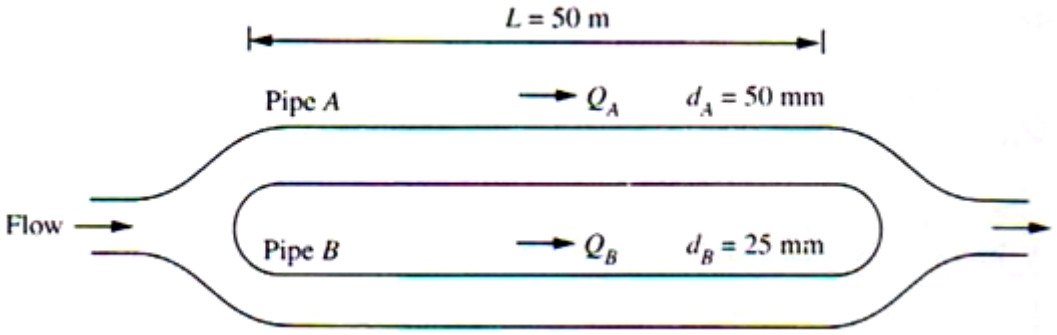


Figure 5

(b) A liquid flows through a short pipe which branches into two parallel pipes A and B each with a length of 50m and with inside diameters of 25mm and 50 mm respectively as refereed in figure 5. Determine the flow through each pipe if they have a drop in elevation of 3 m. Assume a constant friction factor in both pipes of 0.005.

[12 marks]

5. (a) A model is built for a spillway to a scale 1:25. The discharge over spillway is expected to be 1250 m^3/s under a water head of 3 m.

What are corresponding values of discharge and water head in the laboratory?

[5 marks]

(b) The pressure drop Δp in a pipe of diameter D and length L depends on mass density of the fluid ρ and viscosity μ of the fluid flowing, mean velocity of flow U, and on the average height of protuberances, of pipe surface k. Obtain a dimensionless expression for Δp.

[15 marks]

6. With the aid of sketches,

(a) Define the types of flow in an open channel by depth variation. Assume the flow of an irrigation canal starts from Bukit Merah Dam before discharging to Sungai Kurau at the downstream end.

[5 marks]

(b) Describe the energy diagram of a hydraulic jump in a horizontal floor.

[5 marks]

(c) A stream on a plain has a reach that is described as clean and winding with some pools and some weeds. This reach has a reasonably constant slope of 0.0002. The stream cross-section of flow can be approximated as a trapezoid with bottom width equal to 1.5 m and side slopes 1:3. Use the Manning equation with estimated maximum and minimum values of n (Table 1) for open channel flow in this stream to find the range of river discharge and water flow velocity to be expected for a 0.9 m water depth.

[10 marks]

Table 1

NATURAL STREAM			
Type of Channel and Description	**Minimum**	**Normal**	**Maximum**
1. Minor Stream (top width at flood stage < 100 ft)			
a. Stream on plain			
(1) Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
(2) Same as above, but more stones or weeds	0.030	0.035	0.040
(3) Clean, winding, some pools or shoals	0.033	0.040	0.045
(4) Same as above, but some weeds or stones	0.035	0.045	0.050
(5) Same as above, lower stage, more ineffective slopes and sections	0.040	0.048	0.055
(6) Same as (4), but more stones	0.045	0.050	0.060
(7) Sluggish reaches, deep pools	0.050	0.070	0.080
(8) Very weedy reaches, deep pools, or floodway with heavy stand of timber and underbrush	0.075	0.100	0.150

1. *Berdasarkan kepada sungai lebar yang mempunyai dedalaman aliran 2.0 m, cerun dasar 0.002, dan saiz midian bijian dasar saluran berukuran 5 mm. Kira:*

   (a) Halaju ricih

   [3 markah]

   (b) Tegasan Ricih dasar

   [2 markah]

   (c) Buktikan bahawa dasar saluran tidak stabil

   [6 markah]

   (d) Tentukan zaiz bijian minimum bagi mengelakkan

   [5 markah]

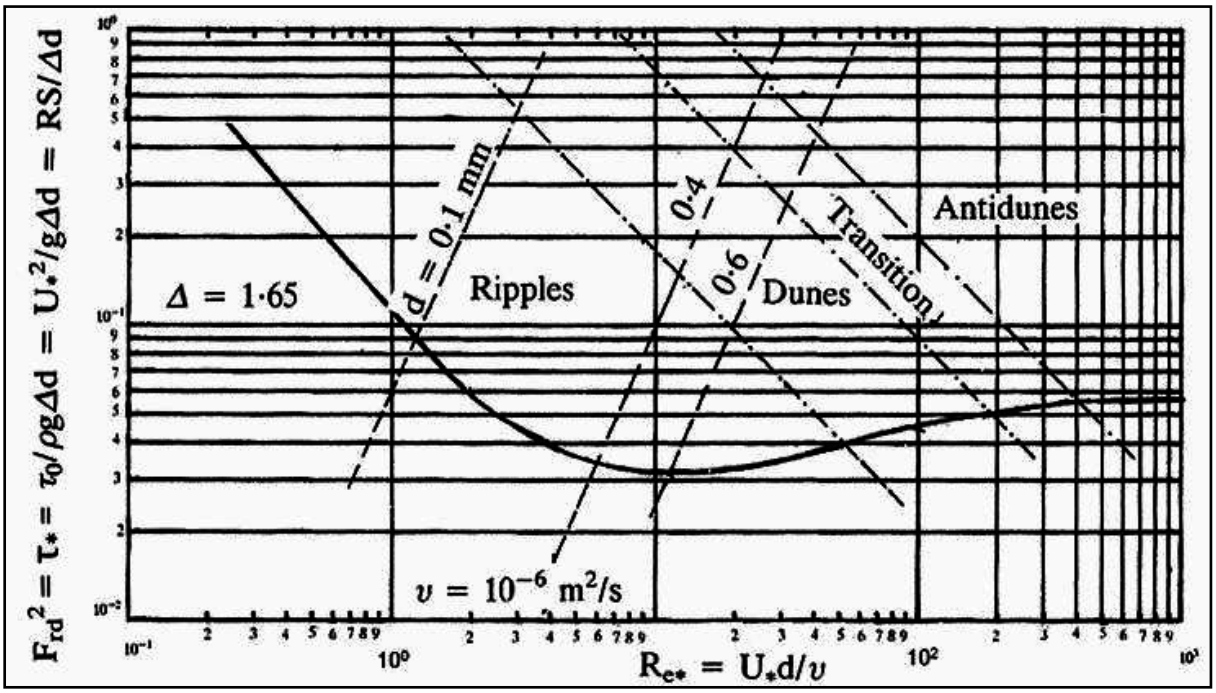
   (e) Senaraikan dua(2) aplikasi pergerakan ambang pengangkutan

   [4 markah]

Gunakan:

Ketumpatan air, ρ	=	*1000*	*kg/m^3*
Ketumpatan endapan, ρs	=	*2650*	*kg/m^3*
Kelikatan kinamatik, v	=	*0.000001*	*m^2/s*
Pecutan graviti, g	=	*9.80*	m/s^2

Rajah Shield *Rajah 1*



Rajah 1: Shield

2. *Sebuah saluran berbentuk empat segi tepat yang mempunyai cerun dasar 0.0009. Bahan dasar ialah campuran zarah ringan (ρs = 2350 kg/m^3) dengan saiz median d_{50} = 1.15mm dan halaju jatuh 0.15 m/s. Kadar aliran ialah 7.9 m^3/s (diandaikan malar) dan kedalam aliran ialah 2.5 m.*

(a) Kira kadar pengangkutan endapan menggunakan.

(i) Persamaan Meyer-Peter-Muller(MPM)

[5 markah]

(ii) Persamaan Einstein - Brown(EB)

[3 markah]

(b) Sekiranya sebuah kolam takungan menpunyai keupayaan storan 20 x 10^6 m^3 hendak dibina, anggarkan hayat kolam takungan tersebut menggunakan persamaan MPM.

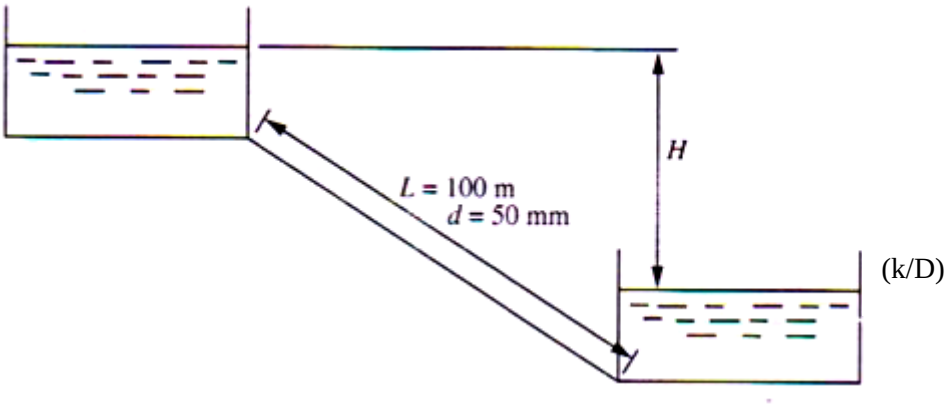
[2 markah]

(c) Terangkan secara ringkas lima (5) kesan pembinaan empangan.

[10 markah]

Gunakan:

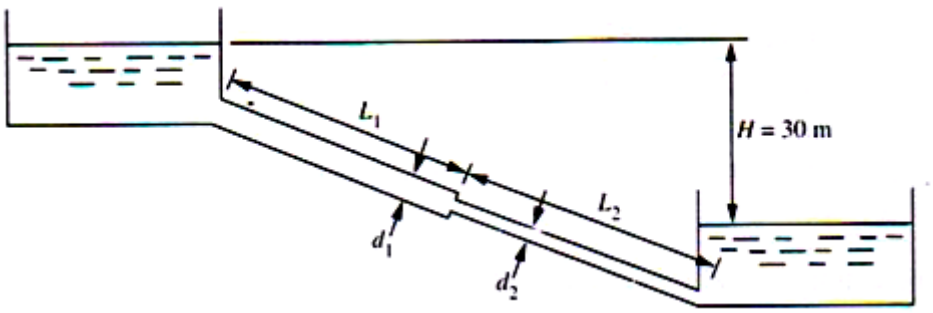
Ketumpatan air, ρ =	*1000*	*kg/m^3*
Kelikatan kinamatik, v =	*0.000001*	*m^2/s*
Pecutan graviti, g =	*9.80*	*m/s^2*



Rajah 2

3. (a) *Dua buah tangki storan disambung oleh paip lurus sepanjang 100m seperti di Rajah 2. Kedua-dua tangki tersebut terbuka dan di sambungkan oleh sebatang paip yang berdiameter 50mm dan mempunyai kekasaran relatif (k/D) 0.002. Tentukan nilai perubahan tekanan sepanjang paip tersebut sekiranya kadar alir adalah 15m^3/jam dan angarkan perbezaan ketinggi antara kedua tangki tersebut. Andaikan ketumpatan ethanol tersebuta adalah 780kg/m^3 dan kelikatan adalah 1.7x10^{-3} Ns/m^2*

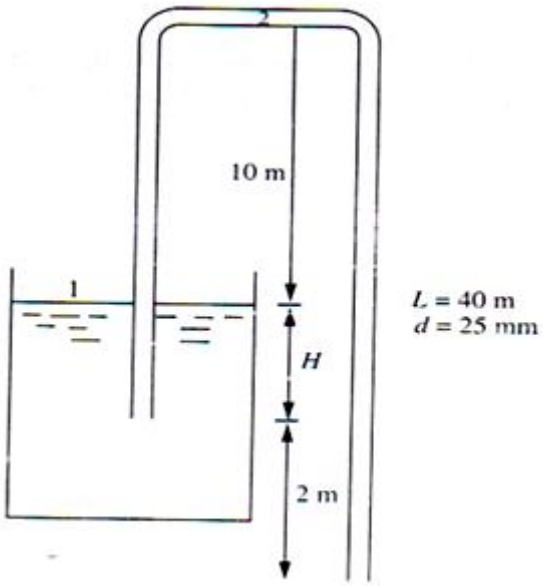
[8 markah]



Rajah 3

(b) *Dua buah kolam takungan disambung oleh sebatang paip lurus sepanjang 1km. Separuh pertama panjang paip tersebut berdiameter 12 sm dan selebihnya dikecilkan kepada 6 sm seperti Rajah 3. Tentukan nilai kadar alir sekiranya perbezaan ketinggi kolam takungan tersebut adalah 30. Andaikan pekali geseran adalah 0.005 untuk kedua-dua paip tersebut.*

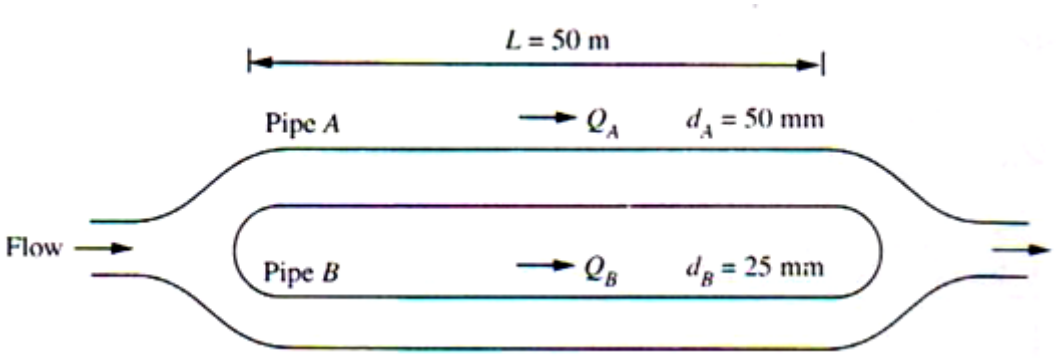
[12 markah]



Rajah 4

4. (a) *Suatu cecair berketumpatan $1.7x10^{-3}$ Ns/m^2 disifonkan melalui sebuah tuib bergarispusat 25mm dan panjangnya adalah 40m seperti di Rajah 4. Tentukan nilai kadar alir siphon tersebut. Andaikan nilai faktor kekasaran adalah 0.005 dan kadar minimum tekanan cecair tersebut adalah $1.7x10^{-3}$ Ns/m^2*

[8 markah]



Rajah 5

(b) *Suatu cecair melalui sebatang paip pendek dan bercabang menjadi 2 batang paip selari A dan B dimana kedua-dua paip tersebut mempunyai panjang 50m dan bergarispusat 25mm dan 50mm seperti di Rajah 5. Tentukan kadar alir yang mengalir untuk setiap paip tersebut sekiranya pengurangan aras adalah 3 m. Andaikan faktor geseran malar untuk kedua-dua paip tersebut adalah 0.005.*

[12 markah]

5. (a) *Sebuah model dibina untuk sebuah spillway untuk skala 1:25. Debit spillway diharapkan 1,250 m3/s dengan tinggi air 3m.*

i) Berapa nilai debit yang sesuai dan tinggi air di makmal?

[5 markah]

(b) *Susutan tekanan Δp dalam sebatang paip bergaris pusat D dan panjang L bergantung kepada ketumpatan jisim bendalir yang mengalir, halaju min aliran U.*

[15 markah]

6. *Berbantukan lakaran,*

(a) *Berikan definisi jenis-jenis aliran dalam saluran terbuka berdasarkan kedalaman aliran yang berbeza. Andaikan air mengalir dalam terusan pengairan bermula dari Empangan Bukit Merah dan berakhir di Sungai Kurau.*

[5 markah]

(b) *Gambarkan diagram tenaga lompatan hidraulik di atas lantai rata.*

[5 markah]

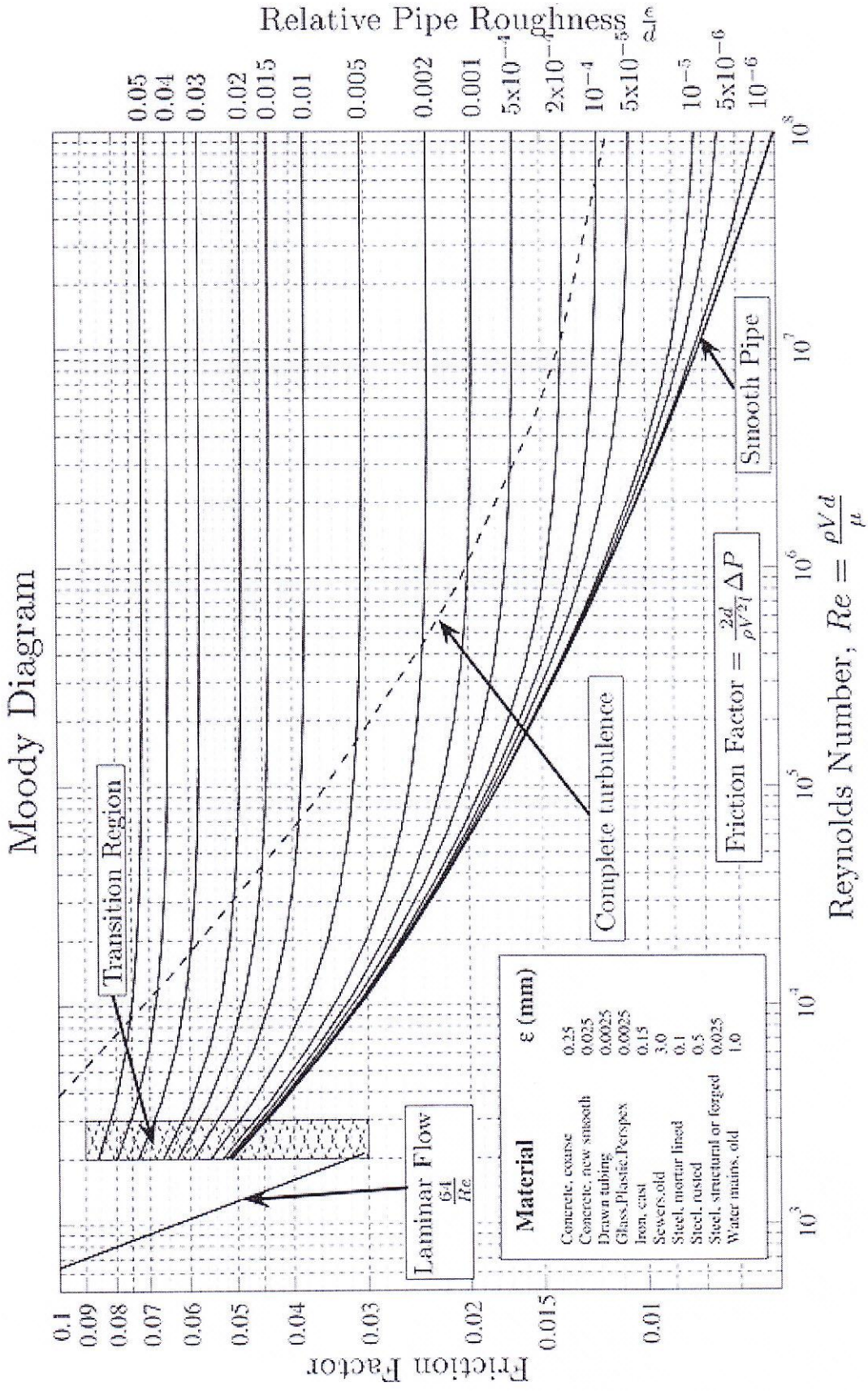
(c) *Sebuah sungai mempunyai cirri-ciri bersih dan berliku yang melalui takungan kecil dan tumbuhan dalam alirannya. Cerun dasar adalah 0.0002 dengan keratin rentas berbentuk trapezoidal dimana cerun sisi adalah 1:3. Dengan menggunakan persamaan Manning, kira kadar alir dan halaju bagi nilai pekali kekasaran Manning yang minimum dan maksimum (Jadual 1).*

[10 markah]

Table 1/*Jadual 1*

NATURAL STREAM			
Type of Channel and Description	**Minimum**	**Normal**	**Maximum**
1. Minor Stream (top width at flood stage < 100 ft)			
a. Stream on plain			
(1) Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
(2) Same as above, but more stones or weeds	0.030	0.035	0.040
(3) Clean, winding, some pools or shoals	0.033	0.040	0.045
(4) Same as above, but some weeds or stones	0.035	0.045	0.050
(5) Same as above, lower stage, more ineffective slopes and sections	0.040	0.048	0.055
(6) Same as (4), but more stones	0.045	0.050	0.060
(7) Sluggish reaches, deep pools	0.050	0.070	0.080
(8) Very weedy reaches, deep pools, or floodway with heavy stand of timber and underbrush	0.075	0.100	0.150

Appendix
Lampiran



oooOOOooo