UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2007/2008

October/November 2007

EBS 238/3 - Fluid Mechanics
[Mekanik Bendalir]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains FOURTEEN printed pages and TWO pages APPENDIX before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi EMPAT BELAS muka surat beserta DUA muka surat LAMPIRAN yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper contains SEVEN questions. THREE questions in PART A and FOUR questions in PART B.
[Kertas soalan ini mengandungi TUJUH soalan. TIGA soalan di BAHAGIAN A dan EMPAT soalan di BAHAGIAN B.]

Instructions: Answer **FIVE** questions. Answer **TWO** questions from PART A, **TWO** questions from PART B and **ONE** question from any sections. If a candidate answers more than five questions, only the first five answers will be examined and awarded marks.
*[**Arahan:** Jawab **LIMA** soalan. Jawab **DUA** soalan dari BAHAGIAN A, **DUA** soalan dari BAHAGIAN B dan **SATU** soalan dari mana-mana bahagian. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

Answer to any question must start on a new page.
[Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

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PART A

BAHAGIAN A

1. [a] Determine P necessary to just start opening the 2 m wide gate.

Kirakan nilai P yang diperlukan untuk membuka get yang mempunyai kelebaran 2 m tersebut.

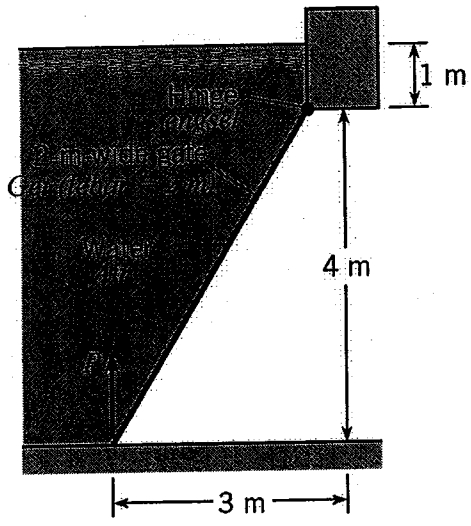

Figure 1

Rajah 1

(25 marks/markah)

[b] Freshwater and seawater flowing in parallel horizontal pipelines are connected to each other by a double U tube manometer, as shown in Figure 2. Determine the pressure difference between the two pipelines. Take the density of seawater at that location to be ρ = 1035 kg/m^3 and specific gravity of oil 0.72.

Air tawar dan air laut mengalir dalam paip secara selari yang dihubungkan antara satu sama lain dengan manometer tiub-U seperti yang ditunjukkan dalam Rajah 2. Dapatkan perbezaan tekanan antara kedua-dua paip tersebut. Anggap ketumpatan air laut ialah ρ = 1035 kg/m^3 dan graviti tentu minyak ialah 0.72.

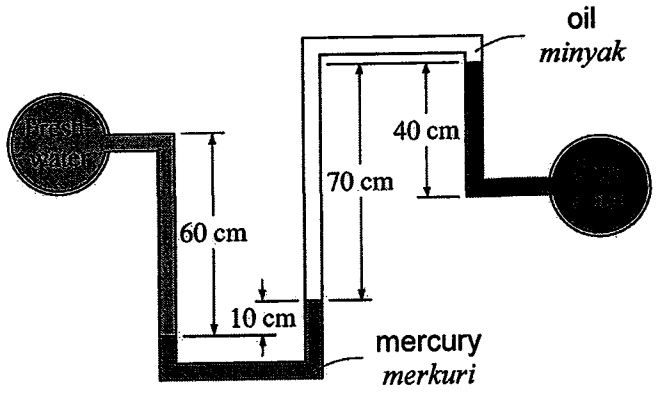

Figure 2

Rajah 2

(25 marks/*markah*)

[c] The barge shown in Figure 3 is loaded such that the center of gravity of the barge and the load is at the waterline. Is the barge stable?

Baj yang ditunjukkan dalam Rajah 3 diisi dengan muatan supaya pusat graviti baj dan muatan ialah pada garisan air. Adakah Baj dalam keadaan stabil?

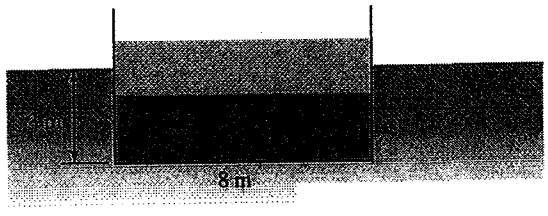

Figure 3

Rajah 3

(25 marks/*markah*)

[d] Find the resultant pressure due to water per meter length, acting on the gate of radius 3 meters as shown in Figure 4.

Dapatkan tekanan paduan disebabkan oleh air bagi setiap meter panjang, yang bertindak pada get berjejari 3 meter seperti yang ditunjukkan dalam Rajah 4.

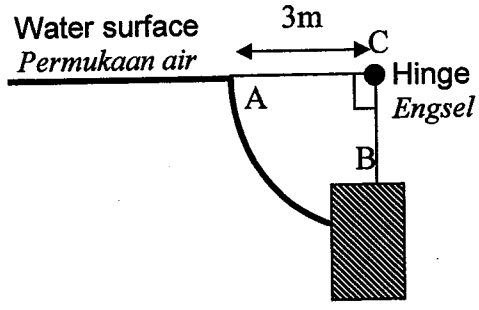

Figure 4

Rajah 4

(25 marks/*markah*)

2. [a] A right-angled V-notch was used to measure the discharge of a centrifugal pump. If the depth of water at V-notch is 200 mm, calculate the discharge over the notch in liters per minutes.

Sebuah empang limpah bersudut tepat bertakuk V digunakan untuk mengukur luahan sebuah pam empar. Jika kedalaman air pada takuk V ialah 200 mm, kirakan luahan yang melalui takuk tersebut dalam liter per minit.

(25 marks/*markah*)

[b] Find the velocity V_1 of the water in the vertical pipe shown in Figure 5. Assume no losses.

Dapatkan kelajuan air V_1 dalam paip menegak seperti yang ditunjukkan dalam Rajah 5. Anggapkan tiada kehilangan.

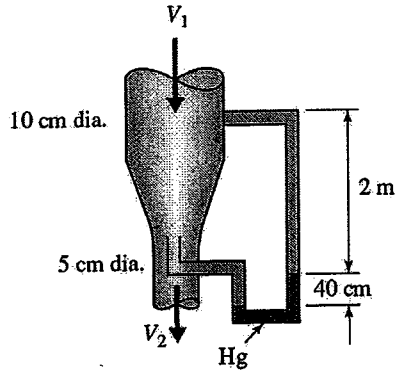

Figure 5

Rajah 5

(25 marks/*markah*)

[c] A venturimeter of throat diameter 0.076 m is fitted in a 0.152 m diameter vertical pipe in which liquid of relative density 0.8 flows downwards. Pressure gauges are fitted to the inlet and the throat sections. The throat being 0.914m below the inlet. Taking the coefficient of meter as 0.97, find the discharge:

(i) when the pressure gauge reads the same

(ii) when the inlet gauge reads 15170N/m^2 higher than throat gauge

Sebuat meter venturi yang mempunyai kerongkongan berdiameter 0.076 dipasangkan pada sebatang paip menegak berdiameter 0.152 m di mana suatu bendalir (ketumpatan relatif = 0.8) mengalir ke bawah. Tolok tekanan dipasang pada salur masuk dan kerongkongan. Kerongkongan terletak 0.914 m dibawah salur masuk. Dengan menganggap koefisien meter ialah 0.97, dapatkan luahan:

(i) bila kedua-dua tolok tekanan menunjukkan bacaan sama

(ii) bila salur masuk memberi bacaan 15170N/m^2 lebih tinggi dari tolok kerongkongan.

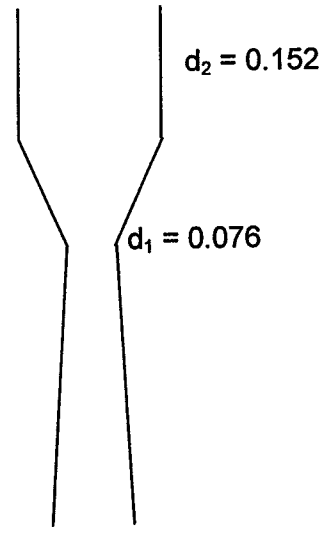

Figure 6

Rajah 6

(50 marks/*markah*)

3. [a] Explain the following:

(i) Inviscid and viscous flow

(ii) Pathlines, streakline and streamlines

(iii) Compressible and incompressible flows

Terangkan yang berikut:

(i) aliran tak likat dan aliran likat

(ii) Garis laluan, garis coreng, dan garis arus

(iii) Aliran mampat dan tak mampat

(25 marks/*markah*)

[b] Water flows in the 5 cm diameter pipe shown in Figure 7 with an average velocity of 10 m/s. It turns a 90° angle and flows radially between two parallel plates. What is the velocity radius of 60 cm? What are the mass flux and discharge?

Air mengalir dalam sebuah paip berdiameter 5 cm seperti yang ditunjukkan dalan Rajah 7 dengan purata kelajuan 10 m/s. Ia membelok pada 90° dan mengalir berjejarian antara dua kepingan selari. Apakah kelajuan jejari 60 cm? Apakah fluk jisim dan luahan?

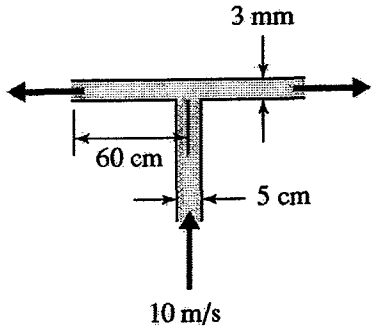

Figure 7

Rajah 7

(25 marks/*markah*)

[c] The diameter of a pipe changes from 20 cm at a section 5 meters above datum, to 5 cm at section 3 meter above datum. The pressure of water at first section is 15 kg/cm^2. If the velocity of flow at first section is 1 m/sec, determine the intensity of pressure at the second section.

Diameter sebuah paip berubah dari 20 cm pada ketinggian 5 meter dari datum kepada 5 cm pada bahagian kedua yang terletak 3 m dari datum seperti dalam Rajah 8. Tekanan air pada bahagian pertama ialah 15 kg/cm^2. Jika kelajuan aliran pada bahagian pertma ialah 1m/s, tentukan tekanan pada bahagian kedua.

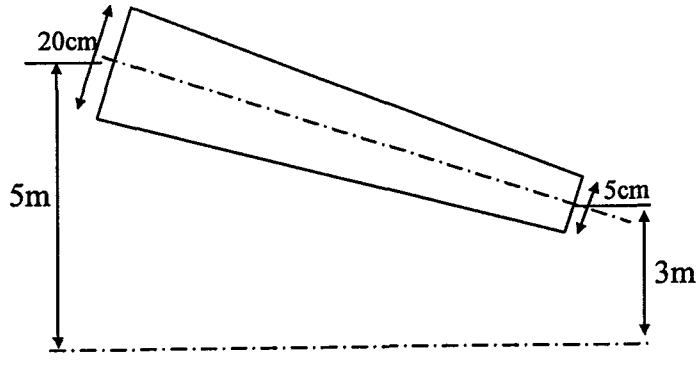

Figure 8

Rajah 8

(25 marks/markah)

[d] Calculate the flow rate of the water flow through the venturi meter shown in Figure 9 if H = 20 cm, $d_1 = 2d_2 = 16$cm.

Kira kadar alir aliran air melalui sebuah meter venturi seperti yang ditunjukkan dalan Rajah 9 jika H = 20cm, $d_1 = 2d_2 = 16$cm.

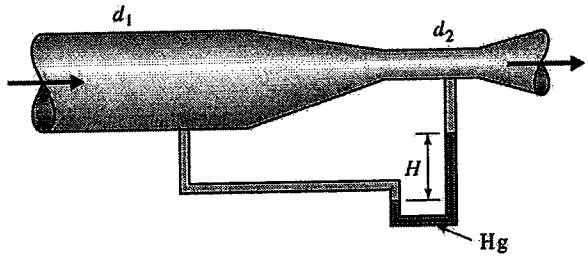

Figure 9

Rajah 9

(25 marks/*markah*)

PART B

BAHAGIAN B

4. [a] The pipe flow in the following Figure 10 is driven by pressurized air in the tank. What gage pressure p_1 is needed to provide a 20°C water flow rate Q = 60 m^3/h?

Aliran dalam paip seperti Rajah 10 berikut dipacu oleh udara bertekanan dalam tangki. Apakah tekanan tolok p_1 diperlukan untuk memberi kadar alir Q = 60 m^3/h pada suhu 20°C?

ρ_{H_2O} = 998 kgm^{-3}

υ_{H_2O} = 1.005 × 10^{-6} m^2s^{-1}

γ_{H_2O} = 9810 nM^{-3}

K_{elbow} = 1.0

K_{sesiku}

$K_{entrance}$ = 0.5

$K_{masukan}$

(70 marks/*markah*)

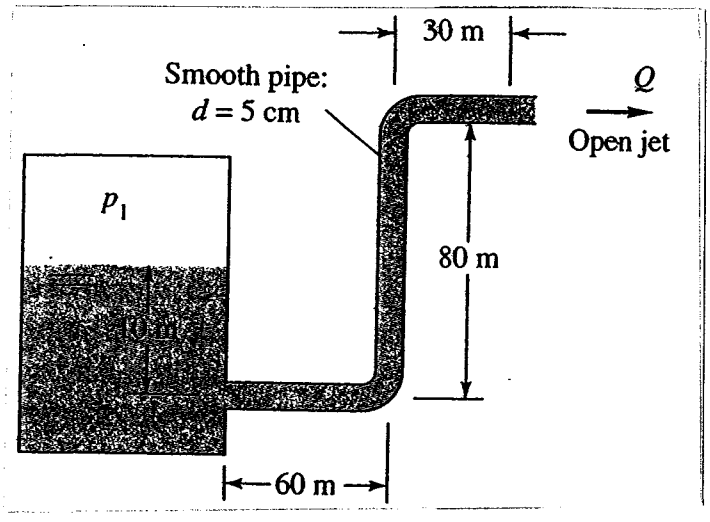

Figure 10

Rajah 10

[b] Minor losses through valves, fittings, bends, contractions and the like are commonly modeled as proportional to (a) total head, (b) static head, (c) velocity head, (d) pressure drop, (e) velocity. Explain.

Kehilangan kecil melalui injap, pemasangan, liku-liku, pengecutan dan sebagainya kebiasaannya dimodelkan berkadar terus kepada (a) jumlah turus, (b) turus statik, (c) turus halaju, (d) kejatuhan tekanan, (e) halaju. Huraikan.

(30 marks/*markah*)

5. [a] Water is flowing in a rectangular channel 2.0 m wide. At a transition section the channel bottom is lowered by h = 0.1 m for a short distance, and then is raised back to the original elevation (see Figure 11). If y = 1.22 m and Q = 4.8 m^3/s, then, with losses neglected:

(i) Find the change in channel width necessary to maintain a horizontal water surface through the transition.

(ii) What change in width would cause critical flow to occur in the transition?

Air mengalir dalam terusan persegi kelebaran 2.0 m. Di bahagian transisi bahagian bawah terusan direndahkan sebanyak h = 0.1 m untuk jarak yang pendek, dan kemudian ia dinaikkan semula kepada aras yang asal (lihat Rajah 11). Jika y = 1.22 m dan Q = 4.8 m^3/s, maka dengan mengabaikan kehilangan:

(i) Carikan pertukaran kelebaran terusan yang diperlukan untuk menetapkan permukaan air dalam keadaan mendatar apabila air melalui kawasan transisi.

(ii) Apakah perubahan kelebaran yang akan mengakibatkan aliran ketara berlaku di bahagian transisi.

(70 marks/*markah*)

g = 9.81 ms^{-2}

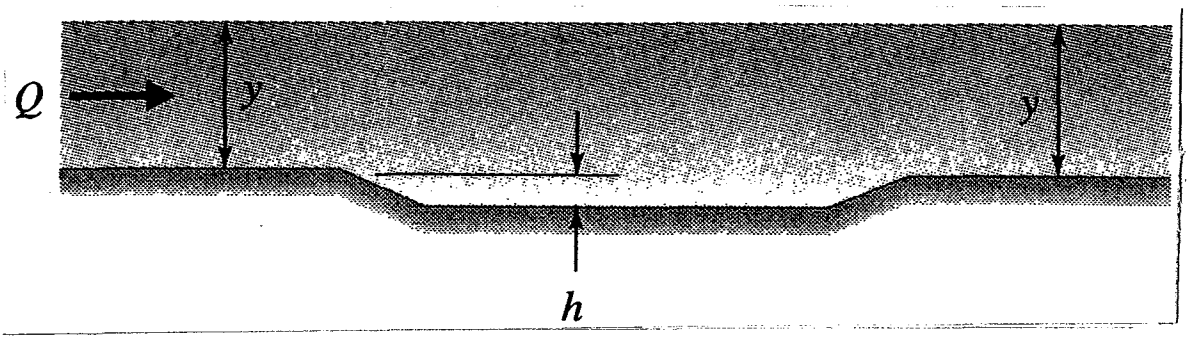

Figure 11

Rajah 11

[b] Free surface problems are driven by gravity. Why do so many of the formulas in this chapter contain the square root of the acceleration of gravity?

Masalah-masalah permukaan bebas dipacu oleh graviti. Mengapakah kebanyakan formula mengandungi punca ganda dua cepatan graviti?

(30 marks/*markah*)

6. [a] Consider the three-reservoir system below with the following data:

Pertimbangkan sistem tiga reservoir di bawah dengan data berikut:

$L_1 = 95$ m $\quad L_2 = 125$ m $\quad L_3 = 160$ m

$z_1 = 25$ m $\quad z_2 = 115$ m $\quad z_3 = 85$ m

All pipes are 28-cm diameter unfinished concrete (e = 1 mm). Compute the steady flow rate in all pipes for water at 20°C (see Figure 12).

Semua paip bergarispusat 28 cm terdiri daripada konkrit tidak licin (e = 1 mm). Kirakan kadar aliran mantap dalam semua paip bagi air pada 20°C (lihat Rajah 12)

(70 marks/*markah*)

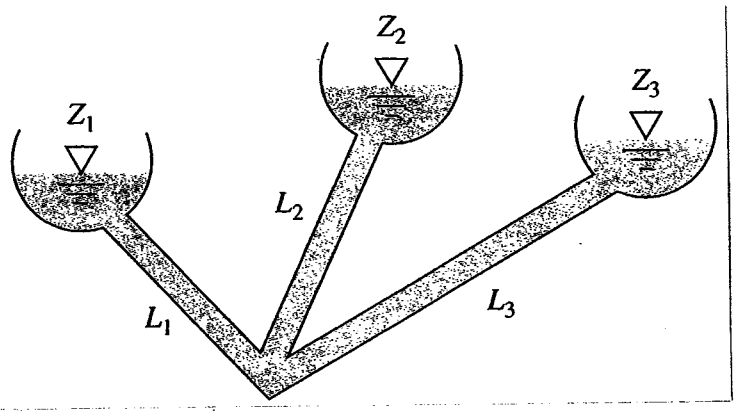

Figure 12
Rajah 12

[b] Identify the correct term on the right-hand side for the formulas on the left-hand side. Include the mathematical symbol representing the related term.

Kenali terma yang betul di sebelah kanan bagi formula di sebelah kiri. Ini hendaklah termasuk simbol-simbol matematiks yang mewakili terma berkaitan.

$\frac{8f_i[L_i + (L_e)_i]}{g\pi^2 D_i^5}$	discharge *keluaran*
$\frac{D_i}{f_i}\Sigma K$	equivalent length *panjang bersamaan*
$\left(\frac{H - z_i}{\overline{R}_i}\right)^{\frac{1}{2}}$	Froude number *nombor Froude*
$y + \frac{q^2}{2gy^2}$	modified pipe resistance *pindaan rintangan paip*
$\frac{q}{\sqrt{gy^3}}$	specific energy *tenaga tentu*

(30 marks/*markah*)

7. [a] A centrifugal pump has d_1 = 17.8 cm, d_2 = 33 cm, b_1 = 10.2 cm, b_2 = 7.6 cm, $\beta_1 = 25^\circ$ and $\beta_2 = 40^\circ$ and rotates at 1160 r/min. If the fluid is gasoline at 20°C and the flow enters the blades radially, estimate the theoretical (a) flow rate, (b) horsepower and (c) head.

Sebuah pam empar mempunyai d_1 = 17.8 cm, d_2 = 33 cm, b_1 = 10.2 cm. b_2 = 7.6 cm, $\beta_1 = 25^0$, dan $\beta_2 = 40^0$ dan berputar pada 1160 putaran/minit. Sekiranya bendalir ini gasolin pada 20°C dan aliran masuk ke dalam bilah-bilah menurut jejari, anggarkan secara teori (a) kadar alir, (b) kuasa kuda, dan (c) turus.

$\rho = 680\ \text{kgm}^{-3}$

$\mu = 2.92 \times 10^{-4}\ \text{kg (ms)}^{-1}$

$\gamma = 6660\ \text{Nm}^{-3}$

(70 marks/*markah*)

[b] Identify the correct term on the right-hand side for the formulas on the left-hand side. Include the mathematical symbol representing the related term.

Kenali terma yang betul di sebelah kanan bagi formula di sebelah kiri. Ini hendaklah termasuk simbol-simbol matematik yang mewakili terma berkaitan.

$\rho Q(r_2 V_{t,2} - r_1 V_{t,1})$	discharge *keluaran*
$\gamma Q H_t$	Euler's turbomachine relation *hubungan mesin turbo Euler*
$\dfrac{u_2 V_2 \cos\alpha_2 - u_1 V_1 \cos\alpha_1}{g}$	power *kuasa*

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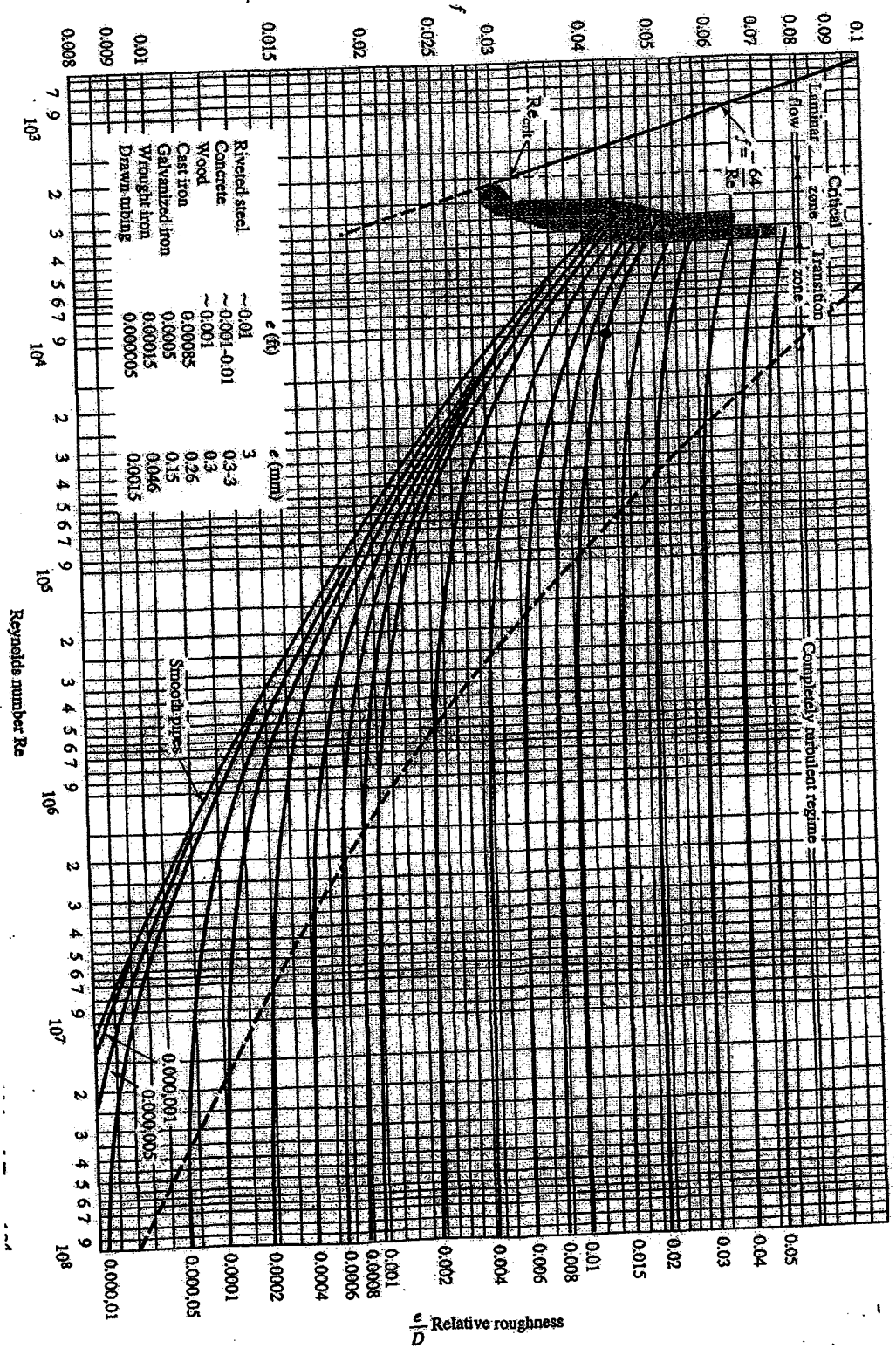
APPENDIX 1

LAMPIRAN 1



APPENDIX 2

LAMPIRAN 2

Properties of Common Liquids at Atmospheric Pressure and Approximately 60 to 70°F (16 to 21°C)

Liquid	*Specific weight* γ		*Density* ρ		*Surface tension*[a] σ		*Vapor pressure* p_v	
	lb/ft^3	N/m^3	$slugs/ft^3$	kg/m^3	lb/ft	N/m	psia	kPa
Alcohol, ethyl	49.3	7 744	1.53	789	0.0015	0.022	—	—
Benzene	56.2	8 828	1.75	902	0.0020	0.029	1.50	10.3
Carbon tetrachloride	99.5	15 629	3.09	1 593	0.0018	0.026	12.50	86.2
Gasoline	42.4	6 660	1.32	680	—	—	—	—
Glycerin	78.6	12 346	2.44	1 258	0.0043	0.063	2×10^{-6}	1.4×10^{-5}
Kerosene	50.5	7 933	1.57	809	0.0017	0.025	—	—
Mercury	845.5	132 800	26.29	13 550	0.032	0.467	2.31×10^{-5}	1.59×10
SAE 10 oil	57.4	9 016	1.78	917	0.0025	0.036	—	—
SAE 30 oil	57.4	9 016	1.78	917	0.0024	0.035	—	—
Turpentine	54.3	8 529	1.69	871	0.0018	0.026	7.7×10^{-3}	5.31×10^{-2}
Water	62.4	9 810	1.94	1000	0.0050	0.073	0.34	2.34

[a]In contact with air.

Properties of Common Liquids at Atmospheric Pressure and Approximately 16^0 to 21^0C

Sifat-Sifat Bendalir Biasa padaTekanan Atmosfera dan Suhu anggaran 16^0 to 21^0C