UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2004/2005

Mac 2005

EMH 102/3 – MEKANIK BENDALIR 1

Masa : 3 jam

ARAHAN KEPADA CALON :

Sila pastikan bahawa kertas soalan ini mengandungi **TUJUH (7)** mukasurat dan **ENAM (6)** soalan **EMPAT (4)** halaman lampiran yang bercetak sebelum anda memulakan peperiksaan.

Pelajar dibenarkan menjawab semua soalan dalam **Bahasa Malaysia**.

Jawap **EMPAT (4)** soalan sahaja.

Jawapan bagi setiap soalan hendaklah dimulakan pada mukasurat yang baru.

Lampiran :

1. Sifat-Sifat Udara pada Tekanan Atmosfera [1 mukasurat]
2. Gambarajah Moody [1 mukasurat]
3. Pemalar Kehilangan pada Pelbagai Sambungan [1 mukasurat]
4. Pemalar Seretan bagi Pelbagai Jasad [1 mukasurat]

S1. [a] Jika 5.27 m^3 suatu minyak yang beratnya 44 kN, tentukan berat tentu, ketumpatan jisim dan gravity tentu bagi minyak.

If 5.27 m^3 of a certain oil weighs 44 kN, determine the specific weight, mass density and specific gravity of the oil.

(30 markah)

[b] Cecair termampat di dalam sebuah silinder mempunyai isipadu 0.01132 m^3 pada tekanan 6.9 MPa. Apakah sepatutnya tekanan baru untuk isipadu menjadi 0.01121 m^3? (Modulus pukal bagi kekenyalan cecair ialah 690 MPa).

A compressed liquid in a cylinder has a volume of 0.01132 m^3 at a pressure of 6.9 MPa. What should be the new pressure in order that its volume becomes 0.01121 m^3? (The bulk modulus of elasticity of the liquid is 690 MPa).

(30 markah)

[c] Agihan halaju diatas sebuah plat diberikan sebagai $u = 2y - y^2$ yang mana u ialah halaju pada arah-x dan y ialah jarak menegak daripada plat. Kirakan kecerunan halaju di sempadan, pada 75 mm dan 150 mm daripada plat dan juga tegasan ricih di titik-titik tersebut. (Kelikatan cecair ialah 0.86 Pas).

The velocity distribution for a liquid flowing over a plate is given by $u = 2y - y^2$ in which u is the x - direction velocity and y is the vertical distance from the plate. Calculate the velocity gradient at the boundary, at 75 mm and 150 mm from the plate and also shear stress at these points. (The viscosity of liquid is 0.86 Pas).

(40 markah)

S2. [a] Lakar dan terangkan penggunaan piezometer atau tiub tekanan bagi mengukur keamatan tekanan didalam cecair.

Sketch and explain the use of a piezometer or pressure tube to measure the intensity of pressure in a liquid.

(20 markah)

[b] Sebuah tiub U terbalik dibahagian atas diisikan dengan cecair bergraviti tentu 0.98 dan selebihnya di dalam tiub diisi dengan air dengan gravity tentu 1.01. Tentukan perbezaan tekanan dalam N/m^2 diantara titik A dan B pada aras sama dengan paras bawah kaki apabila perbezaan paras air h ialah 75 mm.

The top of an inverted U-tube manometer is filled with oil of specific gravity of 0.98 and the remainder of the tube with water of specific gravity of 1.01. Determine the pressure difference in N/m^2 between two points A and B at the same level at the base of the legs when the difference in water level h is 75 mm.

(40 markah)

[c] **Sebahagian kargo berjisim 25,000 kg dipindahkan melalui suatu jarak 6m pada sudut tepat kepada satah menegak mengandungi paksi longitude bagi sebuah kapal menyebabkan ia terpesong pada sudut 5°. Anjakan bagi kapal ialah 5000 tan matrik dan nilai momen kedua bagi luas ialah 5840 m^4. Ketumpatan air laut ialah 1025 kg/m^3. Tentukan ketinggian pusat meta dan ketinggian pusat gravity bagi kapal di atas pusat keapungan.**

The shifting of a portion of cargo of mass 25,000 kg, through a distance of 6m at right angles to the vertical plane containing the longitudinal axis of a vessel, causes it to heel through an angle of 5°. The displacement of the vessel is 5000 metric tons and the value of second moment of area is 5840 m^4. The density of seawater is 1025 kg/m^3. Determine the metacentric height and the height of the center of gravity of the vessel above the center of buoyancy.

(40 markah)

S3. [a] **Terangkan dengan bantuan gambarajah yang kemas, susunan sebuah meter venturi dan terangkan tujuan kegunaan setiap susunan.**

Describe, with the help of a neat diagram, the arrangement of a venturi meter and explain its mode of operation.

(30 markah)

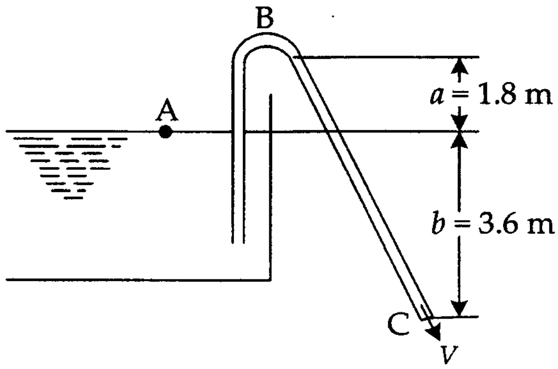
[b] **Terbitkan persamaan Bernoulli bagi aliran bendalir tak boleh mampat tanpa geseran berdasarkan keabadian momentum.**

Derive Bernoulli's equation for the flow of an incompressible frictionless fluid from the conservation of momentum.

(30 markah)

[c] **Sebuah sifon mempunyai lubang bulat bergaris pusat 75 mm dan terdiri daripada paip lengkok dengan lengkokan 1.8 m diatas aras air yang meluah ke atmosfera pada aras 3.6 m dibawah paras air (Rajah S3[c]). Tentukan halaju, luahan dan tekanan mutlak dilengkokan jika tekanan atmosfera adalah bersamaan 10 m air. Abaikan kehilangan disebabkan geseran.**

A siphon has a uniform circular bore of 75 mm diameter and consists of a bent pipe with its crest 1.8 m above water level discharging into the atmosphere at a level 3.6 m below water level (see Figure Q3[c]. Find the velocity, the discharge and the absolute pressure at crest level if the atmospheric pressure is equivalent to 10 m of water. Neglect losses due to friction.



Rajah S3[c]
Figure Q3[c]

(40 markah)

S4. [a] Apakah nilai nombor Reynolds bagi udara pada tekanan 700 kN/m^2 dan suhu 65°C mengalir pada halaju 25 m/s di dalam sebuah paip yang mempunyai garis pusat 15 cm?

What is the value of Reynolds number for air at a pressure of 700 kN/m^2 and a temperature of 65 °C flowing at a velocity of 25 m/s in a pipe having a 15 cm diameter ?

(20 markah)

[b] Sebuah model skala 1:10 bagi sebuah automobil yang digunakan bagi mengukur daya seretan pada rekabentuk yang dicadangkan. Ini bertujuan untuk simulasi sebuah prototaip berhalaju 90 km/h. Kirakan halaju yang sepatutnya digunakan didalam terowong angin bagi keadaan sama dinamik.

A 1:10 scale model of an automobile is used to measure the drag on a proposed design. It is to simulate a prototype speed of 90 km/h. Calculate the speed that should be used in the wind tunnel for dynamically similar conditions.

(30 markah)

[c] Sebuah zarah pepejal jatuh melalui bendalir likat. Halaju jatuh, V dipercayai fungsi ketumpatan bendalir, ρ_f ketumpatan zarah, ρ_p kelikatan bendalir, μ garis pusat zarah, D dan cepatan gravity, g.

A solid particle falls through a viscous fluid. The falling velocity, V is believed to be function of the fluid density, ρ_f the particle density, ρ_p the fluid viscosity, μ the particle diameter, D and the acceleration due to gravity, g.

$$V = f\left(\rho_f, \rho_p, \mu, D, g\right)$$

[c] **Sebuah tiang bendera yang tingginya 17 m mempunyai bentuk silinder bagi garis pusat 100 mm. Angin bertiup melawan tiang bendera dengan halaju 15 m/s dan suhu udara ialah 30°C. Kirakan momen bengkokan pada dasar tiang bendera.**

A flag pole 17 m high has the shape of a cylinder 100 mm in diameter. The wind is blowing against the flag pole with a velocity of 15 m/s and air temperature is 30 °C. Calculate the bending moment about the base of the flag pole.

Derive the shape functions for a quadratic triangular element in terms of local coordinates for the triangle L_i, L_j *and* L_k.

(40 markah)

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Lampiran 1 : Sifat-Sifat Udara Pada Tekanan Atmosfera

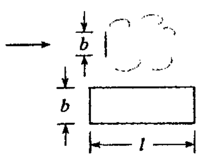
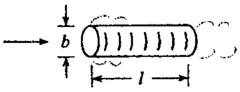
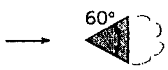
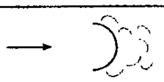
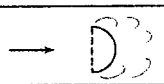
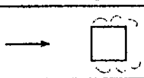
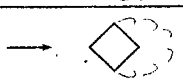
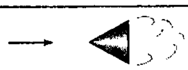
TABLE A.3 MECHANICAL PROPERTIES OF AIR AT STANDARD ATMOSPHERIC PRESSURE

Temperature	Density	Specific weight	Dynamic viscosity	Kinematic viscosity
	kg/m^3	N/m^3	$N \cdot s/m^2$	m^2/s
−20°C	1.40	13.7	1.61×10^{-5}	1.16×10^{-5}
−10°C	1.34	13.2	1.67×10^{-5}	1.24×10^{-5}
0°C	1.29	12.7	1.72×10^{-5}	1.33×10^{-5}
10°C	1.25	12.2	1.76×10^{-5}	1.41×10^{-5}
20°C	1.20	11.8	1.81×10^{-5}	1.51×10^{-5}
30°C	1.17	11.4	1.86×10^{-5}	1.60×10^{-5}
40°C	1.13	11.1	1.91×10^{-5}	1.69×10^{-5}
50°C	1.09	10.7	1.95×10^{-5}	1.79×10^{-5}
60°C	1.06	10.4	2.00×10^{-5}	1.89×10^{-5}
70°C	1.03	10.1	2.04×10^{-5}	1.99×10^{-5}
80°C	1.00	9.81	2.09×10^{-5}	2.09×10^{-5}
90°C	0.97	9.54	2.13×10^{-5}	2.19×10^{-5}
100°C	0.95	9.28	2.17×10^{-5}	2.29×10^{-5}
120°C	0.90	8.82	2.26×10^{-5}	2.51×10^{-5}
140°C	0.85	8.38	2.34×10^{-5}	2.74×10^{-5}
160°C	0.81	7.99	2.42×10^{-5}	2.97×10^{-5}
180°C	0.78	7.65	2.50×10^{-5}	3.20×10^{-5}
200°C	0.75	7.32	2.57×10^{-5}	3.44×10^{-5}
	$slugs/ft^3$	lbf/ft^3	$lbf\text{-}s/ft^2$	ft^2/s
0°F	0.00269	0.0866	3.39×10^{-7}	1.26×10^{-4}
20°F	0.00257	0.0828	3.51×10^{-7}	1.37×10^{-4}
40°F	0.00247	0.0794	3.63×10^{-7}	1.47×10^{-4}
60°F	0.00237	0.0764	3.74×10^{-7}	1.58×10^{-4}
80°F	0.00228	0.0735	3.85×10^{-7}	1.69×10^{-4}
100°F	0.00220	0.0709	3.96×10^{-7}	1.80×10^{-4}
120°F	0.00213	0.0685	4.07×10^{-7}	1.91×10^{-4}
150°F	0.00202	0.0651	4.23×10^{-7}	2.09×10^{-4}
200°F	0.00187	0.0601	4.48×10^{-7}	2.40×10^{-4}
300°F	0.00162	0.0522	4.96×10^{-7}	3.05×10^{-4}
400°F	0.00143	0.0462	5.40×10^{-7}	3.77×10^{-4}

SOURCE: Reprinted with permission from R. E. Bolz and G. L. Tuve, *Handbook of Tables for Applied Engineering Science*, CRC Press, Inc., Cleveland, 1973. Copyright © 1973 by The Chemical Rubber Co., CRC Press, Inc.

Lampiran 4 : Pemalar Seretan bagi Pelbagai Jasad

TABLE 11.1 APPROXIMATE C_D VALUES FOR VARIOUS BODIES

Type of Body		Length Ratio	Re	C_D
	Rectangular plate	$l/b = 1$	$>10^4$	1.18
		$l/b = 5$	$>10^4$	1.20
		$l/b = 10$	$>10^4$	1.30
		$l/b = 20$	$>10^4$	1.50
		$l/b = \infty$	$>10^4$	1.98
	Circular cylinder— axis // to flow	$l/d = 0$ (disk)	$>10^4$	1.17
		$l/d = 0.5$	$>10^4$	1.15
		$l/d = 1$	$>10^4$	0.90
		$l/d = 2$	$>10^4$	0.85
		$l/d = 4$	$>10^4$	0.87
		$l/d = 8$	$>10^4$	0.99
	Square rod	∞	$>10^4$	2.00
	Square rod	∞	$>10^4$	1.50
	Triangular cylinder	∞	$>10^4$	1.39
	Semicircular shell	∞	$>10^4$	1.20
	Semicircular shell	∞	$>10^4$	2.30
	Hemispherical shell		$>10^4$	0.39
	Hemispherical shell		$>10^4$	1.40
	Cube		$>10^4$	1.10
	Cube		$>10^4$	0.81
	Cone—60° vertex		$>10^4$	0.49
	Parachute		$\approx 3 \times 10^7$	1.20

SOURCES: Brevoort and Joyner (4), Lindsey (21), Morrison (24), Roberson et al. (26), Rouse (28), and Scher and Gale (30).

LAMPIRAN 1

Lampiran 1 : Sifat-Sifat Udara Pada Tekanan Atmosfera

TABLE A.3 MECHANICAL PROPERTIES OF AIR AT STANDARD ATMOSPHERIC PRESSURE

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SOURCE: Reprinted with permission from R. E. Bolz and G. L. Tuve, *Handbook of Tables for Applied Engineering Science*, CRC Press, Inc., Cleveland, 1973.

LAMPIRAN 2

Lampiran 2 : Gambarajah Moody

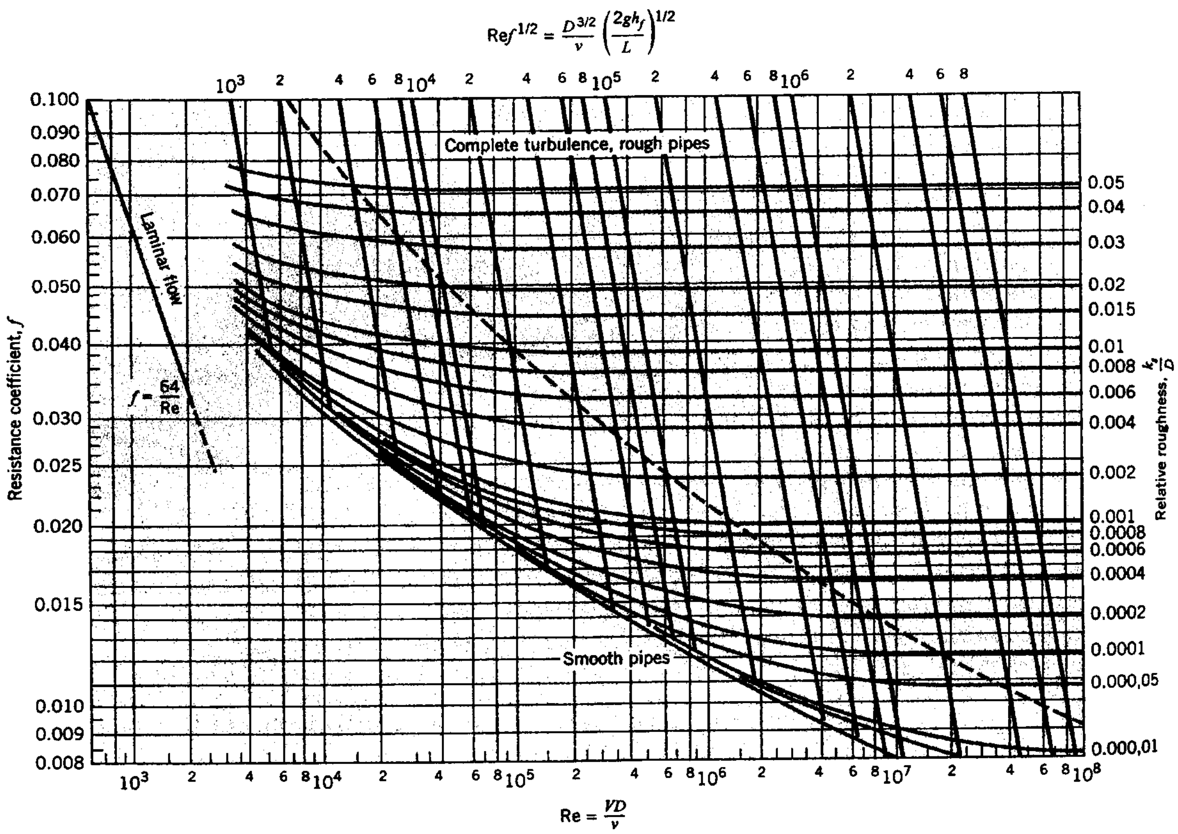


FIGURE 10.8

Resistance coefficient f versus Re. Reprinted with minor variations. [After Moody (31). Reprinted with permission from the A.S.M.E.]

TABLE 10.2 EQUIVALENT SAND-GRAIN ROUGHNESS, k_s, FOR VARIOUS PIPE MA[illegible]

Boundary Material	k_s millimeters	k_s inches
Glass, plastic	smooth	smooth
Copper or brass tubing	0.0015	6×10^{-5}
Wrought iron, steel	0.046	0.002
Asphalted cast iron	0.12	0.005
Galvanized iron	0.15	0.006
Cast iron	0.26	0.010
Concrete	0.3 to 3.0	0.012–0.12
Riveted steel	0.9–9	0.035–0.35
Rubber pipe (straight)	0.025	0.001

Menggunakan analisa dimensi, bentukkan kumpulan-π bagi masalah ini dengan ungkapan keputusan dalam bentuk:

By dimensional analysis, develop the π-groups for this problem expressing the results in the form:

$$\frac{V}{\sqrt{gD}} = f(\pi_1, \pi_2)$$

(50 markah)

S5. [a] Lakar dan terangkan jenis-jenis aliran yang wujud didalam aliran paip. Terangkan parameter yang digunakan bagi mengenal jenis aliran ini dan klasifikasi.

Sketch and explain the flow regimes in a pipe flow. Describe a parameter that used to identify these flow regime and their classifications.

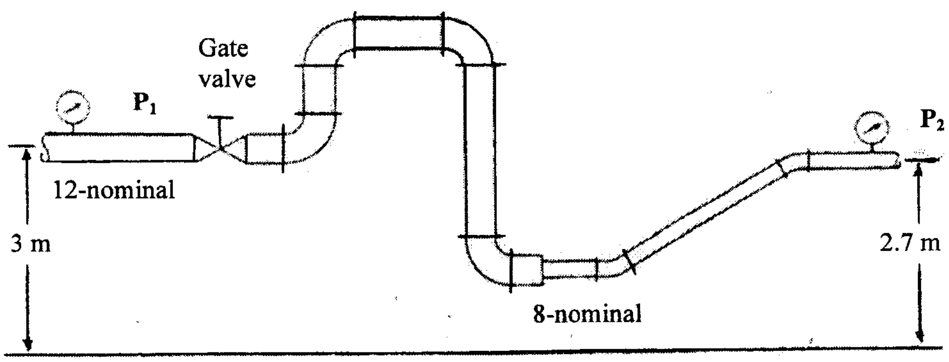
(40 markah)

[b] Dalam loji proses, turpentine disalurkan didalam paip daripada tangki dan ditinkan dan dijual kepada pekedai-pekedai. Sebahagian sambungan paip ditunjukkan dalam Rajah S5[c]. Panjang paip 60 m yang bersaiz nominal 12 dijadualkan 80 batang paip dengan garis pusat dalaman 29 cm dan paip saiz nominal 8 yang panjang 22 m dengan garis pusat dalaman 19 cm. Semua sesiku adalah piawai dan sambungan paip diperbuat daripada keluli komersial. Kadar aliran isipadu ialah 0.05 m^3/s. Kehilangan kecil dalam saiz paip 12 adalah daripada satu injap gate dan 4 sesiku piawai dan bersamaan 1.39 m. Kehilangan kecil didalam saiz paip 8 adalah daripada penumpuan dan dua sesiku dan bersamaan 0.63 m. Tentukan:

(i) Halaju didalam dua jenis paip tersebut
(ii) Nombor Reynolds
(iii) Pemalar geseran
(iv) Kehilangan turus disebabkan geseran
(v) Kejatuhan tekanan, P_1-P_2

In a processing plant, the turpentine is piped from tank to cans that are to be sealed and sold to retail outlets. A portion of pipeline is shown in Figure Q5[c]. There are 60 m of 12 nominal size of schedule 80 pipe with an internal diameter of 29 cm and 22 m of 8 nominal size pipe with an internal diameter of 19 cm. All the elbows are standard and the pipeline is made of commercial steel. The volume flow rate is 0.05 m^3/s. The minor losses in 12 pipe size are from the one gate valve and 4 standard elbows and is equal to 1.39 m. The minor losses in 8 pipe size are from contraction and two elbows and is equal to 0.63 m. Determine:

(i) Velocities in the two pipes
(ii) Reynolds number
(iii) Friction factor
(iv) Head loss due to friction
(v) Pressure drop, P_1-P_2



Rajah S5[c]
Figure Q5[c]

(60 markah)

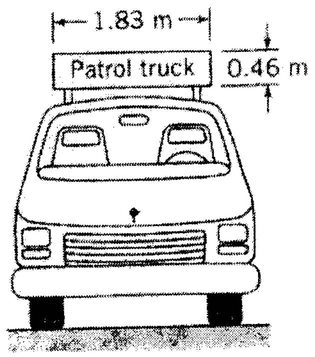
S6. [a] Lakar dan terangkan dengan ringkas bagi tekanan, tegasan ricih dan daya yang bertindak ke atas sebuah airfoil apabila terendam didalam halaju arus bebas.

Sketch and explain briefly the pressure, shear stress and forces acting on an airfoil when it is immersed in the free stream velocity.

(30 markah)

[b] Anggarkan kuasa tambahan yang diperlukan bagi lori apabila ia membawa papan tanda segiempat (seperti ditunjukkan dalam Rajah S6[b] pada halaju 20 m/s lebih berbanding apabila ia bergerak pada halaju yang sama tanpa membawa papan tanda (Anggapkan ketumpatan udara 1.2 kg/m^3).

Estimate the additional power required for the truck when it is carrying the rectangular sign (as shown in Figure Q6[b]) at a speed of 20 m/s over that required when it is traveling at the same speed without carrying the sign (Assume the air density is 1.2 kg/m^3).

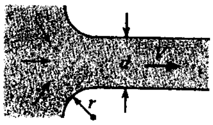
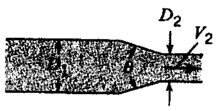
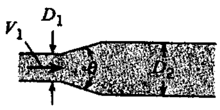
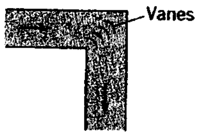
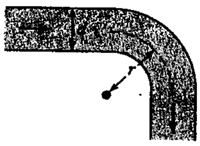


Rajah S6[b]
Figure Q6[b]

(30 markah)

Lampiran 3 : Pemalar Kehilangan pada Pelbagai Sambungan

TABLE [illegible] LOSS COEFFICIENTS FOR VARIOUS TRANSITIONS AND FITTINGS

Description	Sketch	Additional Data		K	Source
Pipe entrance		r/d		K_e	(2)*
$h_L = K_e V^2/2g$		0.0		0.50	
		0.1		0.12	
		>0.2		0.03	
Contraction		D_2/D_1	K_C $\theta = 60°$	K_C $\theta = 180°$	(2)
		0.0	0.08	0.50	
		0.20	0.08	0.49	
		0.40	0.07	0.42	
		0.60	0.06	0.27	
		0.80	0.06	0.20	
$h_L = K_C V_2^2/2g$		0.90	0.06	0.10	
Expansion		D_1/D_2	K_E $\theta = 20°$	K_E $\theta = 180°$	(2)
		0.0		1.00	
		0.20	0.30	0.87	
		0.40	0.25	0.70	
		0.60	0.15	0.41	
$h_L = K_E V_1^2/2g$		0.80	0.10	0.15	
90° miter bend		Without vanes		$K_b = 1.1$	(39)
		With vanes		$K_b = 0.2$	(39)
90° smooth bend		r/d			(5) and (15)
		1	$K_b = 0.35$		
		2	0.19		
		4	0.16		
		6	0.21		
		8	0.28		
		10	0.32		
Threaded pipe fittings	Globe valve—wide open	$K_v = 10.0$			(39)
	Angle valve—wide open	$K_v = 5.0$			
	Gate valve—wide open	$K_v = 0.2$			
	Gate valve—half open	$K_v = 5.6$			
	Return bend	$K_b = 2.2$			
	Tee				
	straight-through flow	$K_t = 0.4$			
	side-outlet flow	$K_t = 1.8$			
	90° elbow	$K_b = 0.9$			
	45° elbow	$K_b = 0.4$			

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Lampiran 4 : Pemalar Seretan bagi Pelbagai Jasad

TABLE 11.1 APPROXIMATE C_D VALUES FOR VARIOUS BODIES

Type of Body	Length Ratio	Re	C_D
Rectangular plate	$l/b = 1$	$>10^4$	1.18
	$l/b = 5$	$>10^4$	1.20
	$l/b = 10$	$>10^4$	1.30
	$l/b = 20$	$>10^4$	1.50
	$l/b = \infty$	$>10^4$	1.98
Circular cylinder—axis // to flow	$l/d = 0$ (disk)	$>10^4$	1.17
	$l/d = 0.5$	$>10^4$	1.15
	$l/d = 1$	$>10^4$	0.90
	$l/d = 2$	$>10^4$	0.85
	$l/d = 4$	$>10^4$	0.87
	$l/d = 8$	$>10^4$	0.99
Square rod	∞	$>10^4$	2.00
Square rod	∞	$>10^4$	1.50
60° Triangular cylinder	∞	$>10^4$	1.39
Semicircular shell	∞	$>10^4$	1.20
Semicircular shell	∞	$>10^4$	2.30
Hemispherical shell		$>10^4$	0.39
Hemispherical shell		$>10^4$	1.40
Cube		$>10^4$	1.10
Cube		$>10^4$	0.81
Cone—60° vertex		$>10^4$	0.49
Parachute		$\approx 3 \times 10^7$	1.20

SOURCES: Brevoort and Joyner (4), Lindsey (21), Morrison (24), Roberson et al. (26), Rouse (28), and Scher and Gale (30).