UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	BFC 1043 / BFC 10403
PROGRAMME	:	1 BFF
EXAMINATION DATE	:	APRIL / MAY 2011
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS

THIS PAPER CONSISTS OF **THIRTEEN (13)** PAGES

Q1 (a) Define the following:

(i) specific weight γ
(ii) specific volume v
(iii) specific gravity SG
(iv) density ρ
(v) kinematic viscosity μ

(5 marks)

(b) A water tank with diameter 10 m and height 5 m is completely filled with water at 25°C. If the water is heated to 50°C, how much volume of water will be spilled?

(5 marks)

(c) A manometer is attached to a tank containing three different fluids as shown in **Figure Q1(c)**. Compute the difference h in the manometer.

(10 marks)

Q2 (a) State the following:

(i) Pascal law
(ii) Archimedes principle

(4 marks)

(b) A water gate of radius 4 m as shown in **Figure Q2(b)** is under equilibrium. It controls the flow of water in a rectangular horizontal channel of width 5 m. Determine the magnitude and direction of the horizontal and vertical forces acting on the gate.

(12 marks)

(c) **Figure Q2(c)** shows a 1.5 m × 1.5 m × 3.0 m concrete block being completely immersed in seawater (ρ = 1025 kg/m^3) by a cable. Determine the tension in the cable if the density of the concrete block is 2500 kg/m^3.

(4 marks)

Q3 (a) A venturi meter shown in **Figure Q3(a)** carries water at 50°C. Calculate the flow rate of the water.

(12 marks)

(b) **Figure Q3(b)** shows a bend carrying an oil (SG = 0.80) at an initial velocity of 2 m/s. If the pressure at the inlet of the bend is 120 kPa, calculate the y-component of force required to hold the bend in place. Assume no energy is lost.

(8 marks)

Q4 (a) List **ONE (1)** major head loss and **THREE (3)** minor head losses incurred in a water distribution system.

(4 marks)

(b) **Figure Q4(b)** shows water at 20°C is pumped between two reservoirs at a rate of 0.30 m^3/min through a 120 m long and 250 mm diameter galvanized iron pipe. Compute the minimum required power provided the pump. Account for all major and minor head losses.

(16 marks)

Q5 (a) Define the following:
(i) hydraulic grade line
(ii) energy grade line

(2 marks)

(b) Sketch the hydraulic grade line and the energy grade line for the pipe system between two reservoirs as shown in **Figure Q5(b)**.

(4 marks)

(c) Determine the flow rate in each of the pipe for the water distribution network as shown in **Figure Q5(c)** using the Hardy-Cross method up to **TWO (2)** iterations only. The constant K for friction loss $h_f = KQ^2$ is given as follows.

Pipe	*AB*	*BC*	*CA*	*BD*	*DC*
K	2	1	2	4	3

(14 marks)

Q6 (a) Using Buckingham's pi theorem, obtain an expression for the flow velocity through an orifice V. The velocity of the orifice flow is a function of the orifice diameter D, the height of water H, gravity acceleration g, dynamic viscosity of fluid μ, and the density of fluid ρ.

(14 marks)

(b) For a 1:20 model of a spillway used, compute:
(i) the velocity of the prototype if the velocity on the model is 1.5 m/s, and
(ii) the flow rate per unit width of the prototype if the flow rate on the model is 0.2 m^3/s.

(6 marks)

S1 (a) Takrifkan yang berikut:
(i) berat tentu γ
(ii) isipadu tentu v
(iii) graviti tentu SG
(iv) ketumpatan ρ
(v) kelikatan kinematik μ

(5 markah)

(b) Sebuah tangki air berdiameter 10 m dan tinggi 5 m diisi penuh dengan air pada 25°C. Jika air tersebut dipanaskan ke 50°C, berapakah isipadu air yang akan melimpah?

(5 markah)

(c) Sebuah manometer dipasangkan ke sebuah tangki yang mengandungi tiga bendalir yang berlainan seperti ditunjukkan dalam **Rajah S1(c)**. Kira perbezaan h dalam manometer.

(10 markah)

S2 (a) Nyatakan yang berikut:
(i) Hukum Pascal
(ii) Prinsip Archimedes

(4 markah)

(b) Sebuah pintu air berjejari 4 m seperti dalam **Rajah S2(b)** berada dalam keadaan keseimbangan. Ia mengawal aliran air dalam sebuah saluran ufuk segiempat dengan lebar 5 m. Kira magnitud dan arah daya-daya mengufuk dan menegak yang bertindak ke atas pintu tersebut.

(12 markah)

(c) **Rajah S2(c)** menunjukkan sebuah blok konkrit 1.5 m × 1.5 m × 3.0 m yang direndam sepenuhnya dalam air laut (ρ = 1025 kg/m^3) menggunakan suatu kabel. Kira tegangan dalam kabel jika ketumpatan blok konkrit ialah 2500 kg/m^3.

(4 markah)

S3 (a) Sebuah venturi meter yang ditunjukkan dalam **Rajah S3(a)** membawa air pada 50°C. Kira kadar alir air.

(12 markah)

(b) **Rajah S3(b)** menunjukkan sebuah siku yang membawa minyak (SG = 0.80) pada halaju awal 2 m/s. Jika tekanan di titik kemasukan siku tersebut ialah 120 kPa, kira daya komponen-y yang diperlukan untuk memegang siku tersebut di kedudukannya. Andai tiada kehilangan tenaga.

(8 markah)

S4 (a) Senaraikan **SATU (1)** kehilangan turus utama dan **TIGA (3)** kehilangan turus kecil yang berlaku dalam sebuah sistem pengagihan air.

(4 markah)

(b) **Rajah S4(b)** menunjukkan air pada 20°C yang dipam di antara dua takungan pada kadar 0.30 m^3/min melalui sebuah paip besi bergalvani 120 m panjang dan berdiameter 250 mm. Kira keperluan kuasa minimum yang dibekalkan oleh pam. Ambilkira semua kehilangan utama dan kecil.

(16 markah)

S5 (a) Takrifkan yang berikut:
(i) garis cerun hidraulik
(ii) garis cerun tenaga

(2 markah)

(b) Lakarkan garis cerun hidraulik dan garis cerun tenaga untuk sistem paip di antara dua takungan seperti yang ditunjukkan dalam **Rajah S5(b)**.

(4 markah)

(c) Kira kadar alir dalam setiap paip untuk rangkaian pengagihan air seperti dalam **Rajah S5(c)** menggunakan kaedah Hardy-Cross sehingga kepada **DUA (2)** cubaan sahaja. Pekali K untuk kehilangan geseran $h_f = KQ^2$ diberi seperti berikut.

Paip	*AB*	*BC*	*CA*	*BD*	*DC*
K	2	1	2	4	3

(14 markah)

S6 (a) Menggunakan teorem pi Buckingham, dapatkan suatu persamaan untuk halaju aliran menerusi sebuah orifis V. Halaju aliran orifis adalah fungsi diameter orifis D, ketinggian air H, pecutan graviti g, kelikatan dinamik bendalir μ, dan ketumpatan bendalir ρ.

(14 markah)

(b) Untuk sebuah model 1:20 alurlimpah yang digunakan, kira:
(i) halaju prototaip jika halaju pada model ialah 1.5 m/s, dan
(ii) kadar alir per unit lebar prototaip jika kadar alir pada model ialah 0.2 m^3/s.

(6 markah)

FINAL EXAMINATION

SEMESTER/SESSION	: II/2010/2011	PROGRAMME	: 1 BFF
COURSE NAME	: FLUID MECHANICS	CODE OF COURSE	: BFC 1043/ BFC 10403

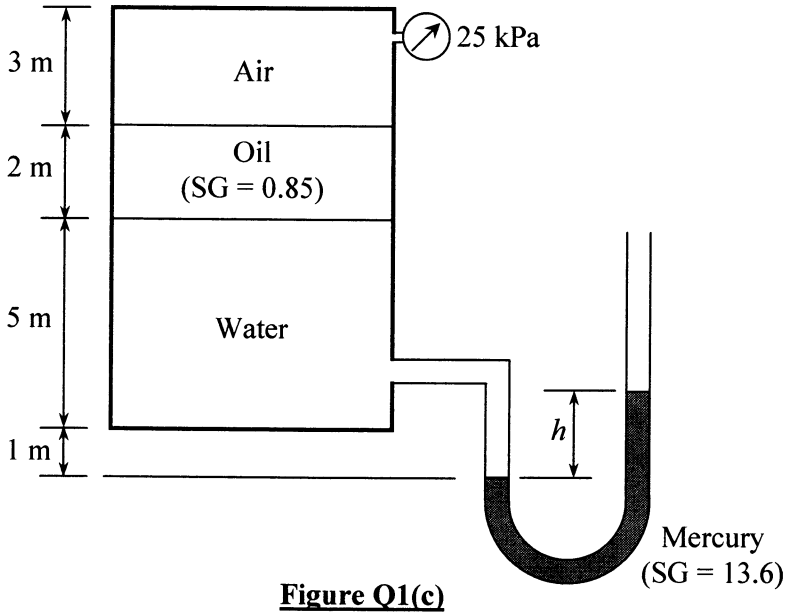

Figure Q1(c)

Rajah S1(c)

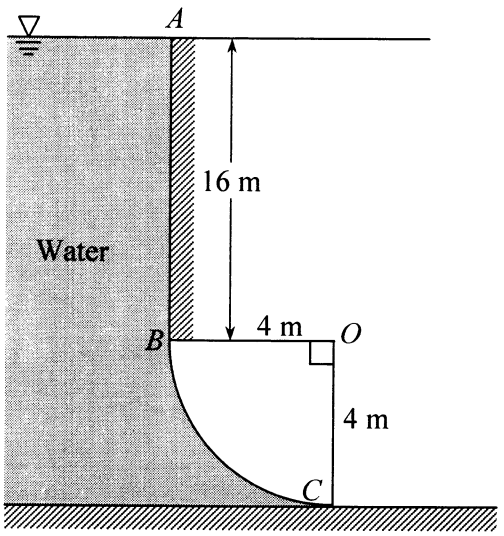

Figure Q2(b)

Rajah S2(b)

FINAL EXAMINATION

SEMESTER/SESSION	: II/2010/2011	PROGRAMME	: 1 BFF
COURSE NAME	: FLUID MECHANICS	CODE OF COURSE	: BFC 1043/ BFC 10403

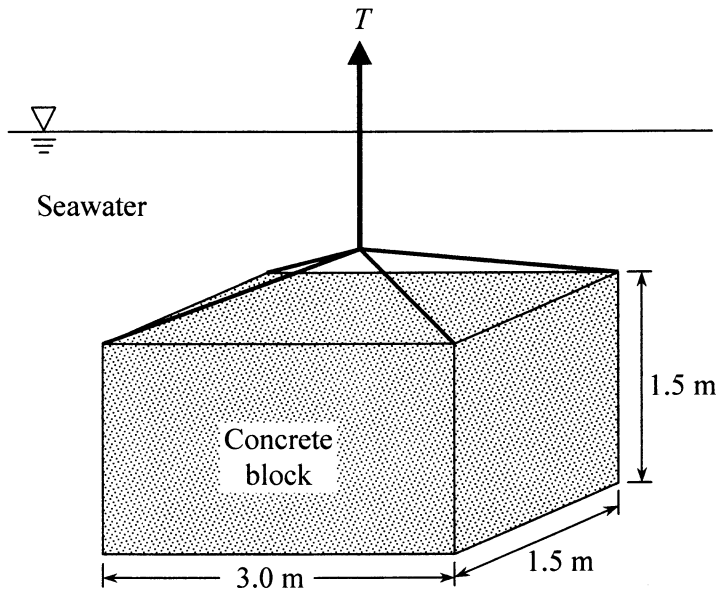

Figure Q2(c)

Rajah S2(c)

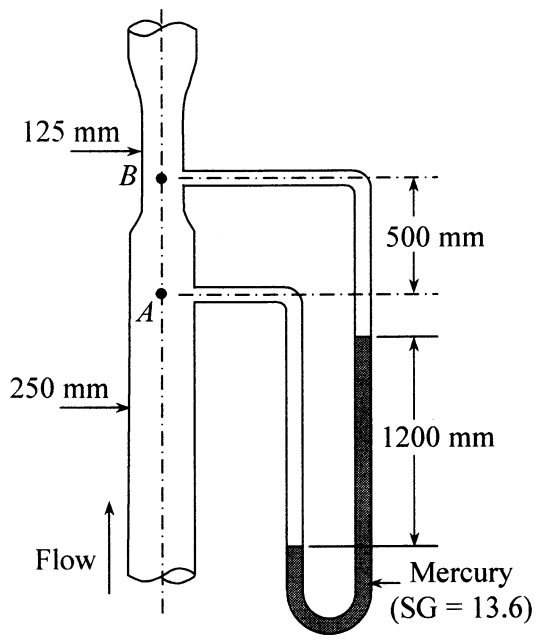

Figure Q3(a)

Rajah S3(a)

FINAL EXAMINATION

SEMESTER/SESSION	: II/2010/2011	PROGRAMME	: 1 BFF
COURSE NAME	: FLUID MECHANICS	CODE OF COURSE	: BFC 1043/ BFC 10403

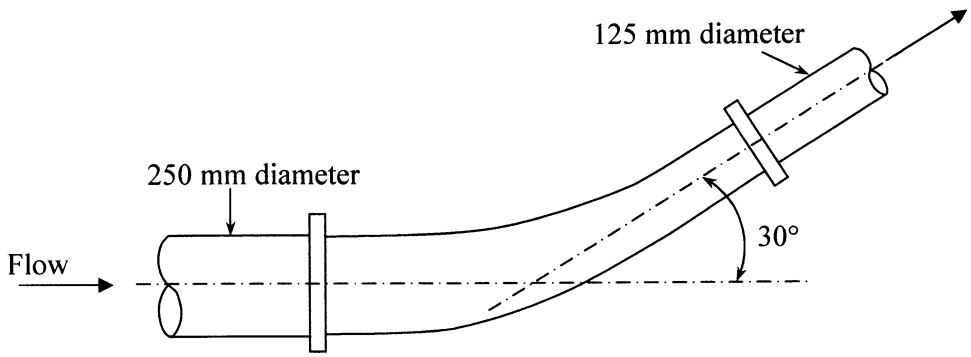

Figure Q3(b)

Rajah S3(b)

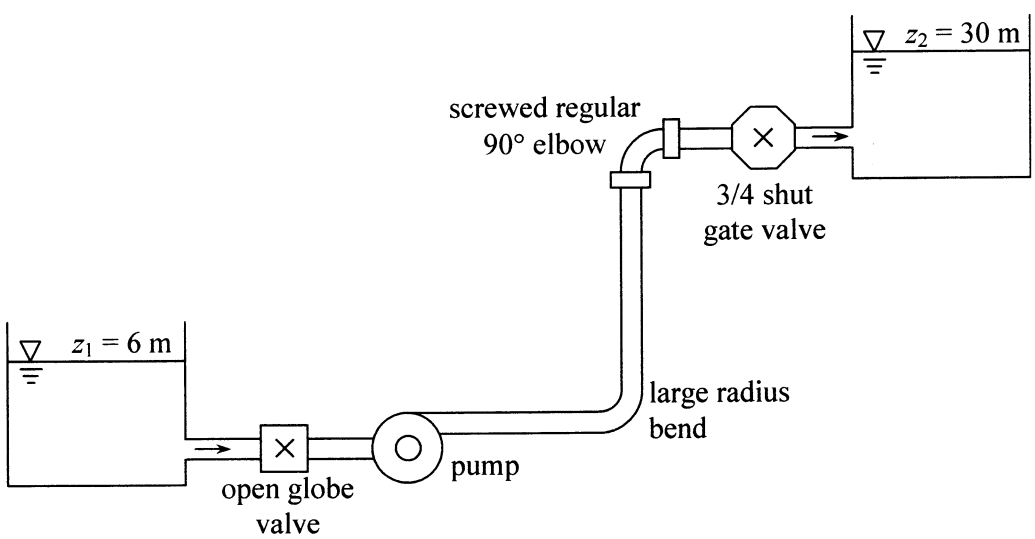

Figure Q4(b)

Rajah S4(b)

FINAL EXAMINATION

SEMESTER/SESSION	: II/2010/2011	PROGRAMME	: 1 BFF
COURSE NAME	: FLUID MECHANICS	CODE OF COURSE	: BFC 1043/ BFC 10403

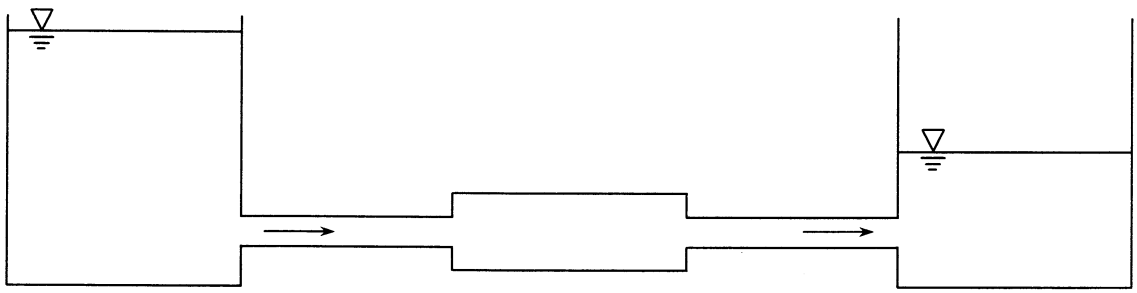

Figure Q5(b)

Rajah S5(b)

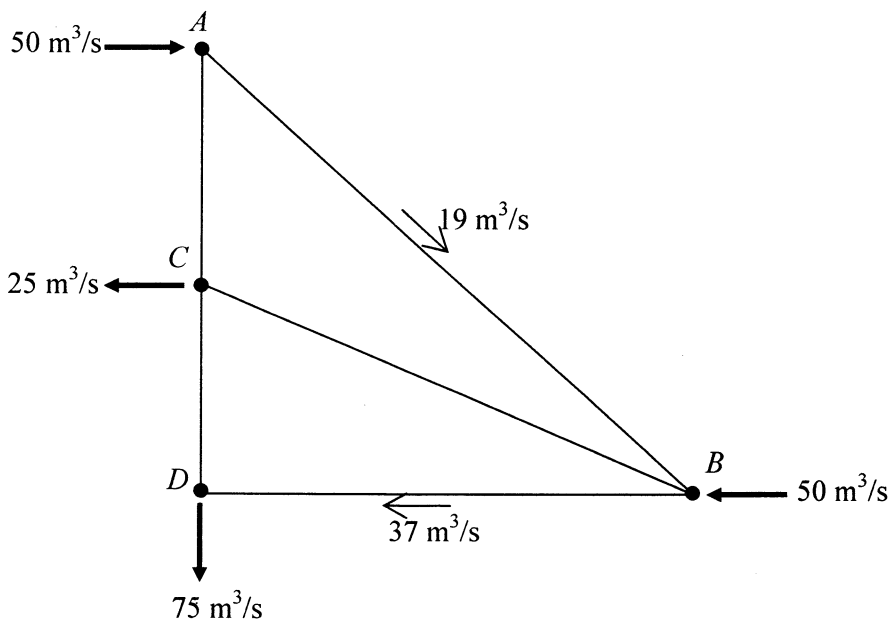

Figure Q5(c)

Rajah S5(c)

FINAL EXAMINATION

SEMESTER/SESSION : II/2010/2011 PROGRAMME : 1 BFF

COURSE NAME : FLUID MECHANICS COURSE CODE : BFC 1043/ BFC 10403

Table 1. Physical properties of water at standard sea-level atmospheric pressure

Jadual 1. Sifat-sifat fizikal air pada tekanan atmosfera paras laut piawai

Temperature T	Specific weight γ	Density ρ	Absolute viscosity μ	Kinematic viscosity ν	Surface tension σ	Saturation vapor pressure p_v	Bulk modulus of elasticity E_v
°F	lb/ft^3	slugs/ft^3	10^{-6} lb·sec/ft^2	10^{-6} ft^2/sec	lb/ft	psia	psi
32°F	62.42	1.940	37.46	19.31	0.00518	0.0885	293,000
40°F	62.43	1.940	32.29	16.64	0.00514	0.122	294,000
50°F	62.41	1.940	27.35	14.10	0.00509	0.178	305,000
60°F	62.37	1.938	23.59	12.17	0.00504	0.256	311,000
70°F	62.30	1.936	20.50	10.59	0.00498	0.363	320,000
80°F	62.22	1.934	17.99	9.30	0.00492	0.507	322,000
90°F	62.11	1.931	15.95	8.26	0.00486	0.698	323,000
100°F	62.00	1.927	14.24	7.39	0.00480	0.949	327,000
110°F	61.86	1.923	12.84	6.67	0.00473	1.275	331,000
120°F	61.71	1.918	11.68	6.09	0.00467	1.692	333,000
130°F	61.55	1.913	10.69	5.58	0.00460	2.22	334,000
140°F	61.38	1.908	9.81	5.14	0.00454	2.89	330,000
150°F	61.20	1.902	9.05	4.76	0.00447	3.72	328,000
160°F	61.00	1.896	8.38	4.42	0.00441	4.74	326,000
170°F	60.80	1.890	7.80	4.13	0.00434	5.99	322,000
180°F	60.58	1.883	7.26	3.85	0.00427	7.51	318,000
190°F	60.36	1.876	6.78	3.62	0.00420	9.34	313,000
200°F	60.12	1.868	6.37	3.41	0.00413	11.52	308,000
212°F	59.83	1.860	5.93	3.19	0.00404	14.69	300,00
°C	kN/m^3	kg/m^3	N·s/m^2	10^{-6} m^2/s	N/m	kN/m^2 abs	10^6 kN/m^2
0°C	9.805	999.8	0.001781	1.785	0.0756	0.611	2.02
5°C	9.807	1000.0	0.001518	1.519	0.0749	0.872	2.06
10°C	9.804	999.7	0.001307	1.306	0.0742	1.230	2.10
15°C	9.798	999.1	0.001139	1.139	0.0735	1.710	2.14
20°C	9.789	998.2	0.001002	1.003	0.0728	2.34	2.18
25°C	9.777	997.0	0.000890	0.893	0.0720	3.17	2.22
30°C	9.765	995.7	0.000798	0.800	0.0712	4.24	2.25
40°C	9.731	992.2	0.000653	0.658	0.0696	7.38	2.28
50°C	9.690	988.0	0.000547	0.553	0.0679	12.33	2.29
60°C	9.642	983.2	0.000466	0.474	0.0662	19.92	2.28
70°C	9.589	977.8	0.000404	0.413	0.0644	31.16	2.25
80°C	9.530	971.8	0.000354	0.364	0.0626	47.34	2.20
90°C	9.467	965.3	0.000315	0.326	0.0608	70.10	2.14
100°C	9.399	958.4	0.000282	0.294	0.0589	101.33	2.07

FINAL EXAMINATION

SEMESTER/SESSION : II/2010/2011 PROGRAMME : 1 BFF

COURSE NAME : FLUID MECHANICS COURSE CODE : BFC 1043/ BFC 10403

Table 2. Dimensions of fluid mechanics quantities

Jadual 2. Dimensi-dimensi kuantiti mekanik bendalir

No.	Kuantiti	*Quantity*	Dimensi (*Dimension*)	
			Sistem M-L-T	Sistem F-L-T
A	***Kuantiti Asasi***	***Fundamental Quantities***		
1	Jisim *m*	*Mass m*	M	$FL^{-1}T^2$
2	Panjang *L*	*Length L*	L	L
3	Masa *t*	*Time t*	T	T
B	***Kuantiti Geometrik***	***Geometric Quantities***		
4	Luas *A*	*Area A*	L^2	L^2
5	Isipadu $\forall$	*Volume* $\forall$	L^3	L^3
6	Momen inersia	*Moment of inertia*	L^4	L^4
C	***Kuantiti Kinematik***	***Kinematic Quantities***		
7	Halaju linear *U, V*	*Linear velocity U, V*	LT^{-1}	LT^{-1}
8	Halaju sudut ω	*Angular velocity* ω	T^{-1}	T^{-1}
9	Halaju putaran *N*	*Rotational speed N*	T^{-1}	T^{-1}
10	Pecutan *a*	*Acceleration a*	LT^{-2}	LT^{-2}
11	Pecutan sudut α	*Angular acceleration* α	T^{-2}	T^{-2}
12	Kadar alir *Q*	*Flow rate Q*	L^3T^{-1}	L^3T^{-1}
13	Graviti *g*	*Gravity g*	LT^{-2}	LT^{-2}
14	Kelikatan kinematik ν	*Kinematic viscosity* ν	L^2T^{-1}	L^2T^{-1}
15	Fungsi arus ψ	*Stream function* ψ	L^2T^{-1}	L^2T^{-1}
16	Putaran Γ	*Circulation* Γ	L^2T^{-1}	L^2T^{-1}
17	Vortisiti Ω	*Vorticity* Ω	T^{-1}	T^{-1}
D	***Kuantiti Dinamik***	***Dynamic Quantities***		
18	Daya *F*	*Force F*	MLT^{-2}	F
19	Ketumpatan ρ	*Density* ρ	ML^{-3}	$FL^{-4}T^2$
20	Berat tentu γ	*Specific weight* γ	$ML^{-2}T^{-2}$	FL^{-3}
21	Kelikatan dinamik μ	*Dynamic viscosity* μ	$ML^{-1}T^{-1}$	$FL^{-2}T$
22	Tekanan *p*	*Pressure p*	$ML^{-1}T^{-2}$	FL^{-2}
23	Tegasan ricih τ	*Shear stress* τ	$ML^{-1}T^{-2}$	FL^{-2}
24	Modulus keanjalan *E, K*	*Modulus of elasticity E, K*	$ML^{-1}T^{-2}$	FT
25	Momentum	*Momentum*	MLT^{-1}	FLT
26	Momentum sudut	*Angular momentum*	ML^2T^{-1}	FLT
27	Momen momentum	*Moment of momentum*	ML^2T^{-1}	$FL^{-4}T^2$
28	Kerja *W*	*Work W*	ML^2T^{-2}	FL
29	Tenaga *E*	*Energy E*	ML^2T^{-2}	FL
30	Torque *T*	*Torque T*	ML^2T^{-2}	FL
31	Kuasa *P*	*Power P*	ML^2T^{-3}	FLT^{-1}

FINAL EXAMINATION

SEMESTER/SESSION	: II/2010/2011	PROGRAMME	: 1 BFF
COURSE NAME	: FLUID MECHANICS	COURSE CODE	: BFC 1043/ BFC 10403

Table 3. Head loss coefficients for a range of pipe fittings

Jadual 3. Pekali kehilangan turus untuk pelbagai kelengkapan paip

Fitting	Loss coefficient k
Gate valve (open to 75 percent shut)	20
Globe valve	10
Spherical plug valve (fully open)	0.1
Pump foot valve	1.5
Return bend	2.2
90° elbow	0.9
45° elbow	0.4
Large-radius 90° bend	0.6
Tee junction	1.8
Sharp pipe entry	0.5
Radiused pipe entry	0.0
Sharp exit pipe	0.5