UNIVERSITI SAINS MALAYSIA

Peperiksaan Kursus Semasa Cuti Panjang
Sidang Akademik 2008/2009

Jun 2009

EEM 223 – TERMOBENDALIR

Masa: 3 jam

Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH muka surat dan DUA muka surat LAMPIRAN yang bercetak sebelum anda memulakan peperiksaan ini.

Kertas soalan ini mengandungi ENAM soalan.

Jawab **LIMA** soalan.

Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.

Agihan markah bagi setiap soalan diberikan di sudut sebelah kanan soalan berkenaan.

Jawab semua soalan dalam bahasa Malaysia atau bahasa Inggeris atau kombinasi kedua-duanya.

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1. [a] Proses isoterma (1→2) bagi gas sempurna diberi mengikut hukum (pv=malar). Tunjukkan kerja terlaku oleh gas adalah

An isothermal process (1→2) for an ideal gas is given by the law (pv= constant). Show that the work done by the gas is

$$W = RT_1 \ln \frac{P_1}{P_2}$$

di sini R= pemalar gas
gas constant

P= tekanan
Pressure

T= suhu
temperature

v= isipadu tentu
specific volume

(40 markah)

[b] Udara dengan jisim 6kg mengembang secara boleh-balik daripada tekanan 13bar kepada 1.3bar mengikut hukum $pv^{1.2}$= malar. Jika isipadu udara pada keadaan awal ialah $0.1m^3$, tentukan:

Air with a mass of 6kg expands reversibly from a pressure of 13bar to 1.3bar using the law of $pv^{1.2}$= constant. If the initial volume of air is $0.1m^3$, determine:

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(i) kerja terlaku
work done

(ii) pemindahan haba
heat transfer

(60 markah)

2. [a] Dengan menggunakan hukum pertama termodinamik bagi sistem tertutup (abaikan perubahan tenaga kinetik dan tenaga keupayaan), terbitkan perhubungan;

Using the first law of thermodynamics for a closed system (neglect the changes in the kinetic and potential energies), derive the relation:

$$Tds = dh - vdp$$

Di sini T= suhu, s= entropi, h= entalpi, *v*= isipadu tentu dan p= tekanan

where T= temperature, s= entropy, h= enthalpy, v= specific volume and p= pressure

(40 markah)

[b] Pemanas air suapan beroperasi pada keadaan mantap mempunyai dua salur masuk dan satu salur keluar. Pada salur masuk yang pertama, wap masuk pada tekanan p_1= 700kPa, T_1= 200°C dengan kadar aliran jisim 40kg/s. Di salur masuk kedua, air cecair pada tekanan p_2= 700kPa, T_2 = 40°C masuk dengan keluasan A_2= 25cm^2. Cecair tepu pada tekanan p_3= 700kPa keluar dengan kadar di mana isipadu 0.06m^3/s. Tentukan kadar aliran jisim di salur masuk kedua dan salur keluar, dan kirakan halaju di salur masuk kedua.

A feed water heater operating at steady has two inlets and one exit. At the first inlet, water vapor enters at p_1= 700kPa, T_1= 200°C with a mass flow rate of 40kg/s. At the second inlet, liquid water at p_2= 700kPa, T_2 = 40°C enters through an area of A_2= 25cm^2. Saturated liquid at p_3= 700kPa exits with a volumetric flow rate 0.06m^3/s. Determine the mass flow rate at the second and at the exit, and the velocity at the second inlet.

(60 markah)

3. [a] Sebuah enjin mempunyai kecekapan 100%. Terangkan samada enjin tersebut melanggar hukum pertama termodinamik dan hukum kedua termodinamik. Nyatakan hukum kedua termodinamik berdasarkan ungkapan Clausius.

An engine has an efficiency of 100%. Explain whether or not it violates the first law and the second law of thermodynamics. State the second law of thermodynamics as expressed by Clausius.

(30 markah)

[b] Wap memasuki sebuah turbin dengan tekanan 30bar, suhu 400°C, dan halaju 160m/s. Wap tepu pada 100°C keluar dengan halaju 100m/s. Pada keadaan mantap, turbin menghasilkan kerja bersamaan 540kW setelah wap mengalir melalui turbin. Haba terpindah daripada turbin ke persekitaran adalah 10kW. Abaikan tenaga keupayaan dan

Steam enters a turbine with a pressure of 30bar, a temperature 400°C, and a velocity of 160m/s. Saturated vapor at 100°C exits with a velocity of 100m/s. At steady state, the turbine develops work equal to 540kW of steam flowing through the turbine. Heat transfer from the turbine to its surroundings is 10kW. Neglect the potential energy and

(i) tentukan kadar aliran jisim wap
determine the mass flow rate of steam

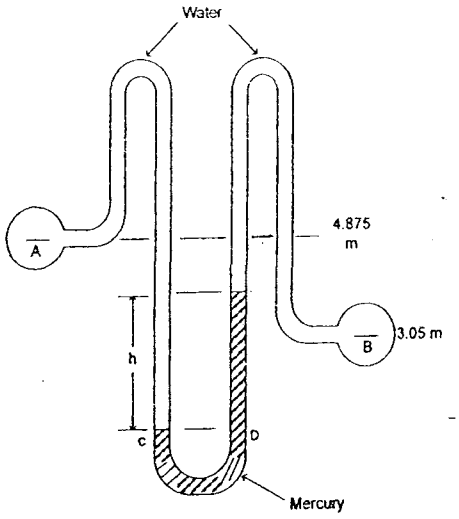
(ii) tunjukkan proses adalah tak boleh balik
show that the process is irreversible

(iii) kirakan perubahan entropi
calculate the change of entropy

(70 markah)

4. [a] Kebuk A dan B mengandungi air masing-masing pada tekanan 275kPa dan 140kPa seperti yang ditunjukkan dalam Rajah 1[a]. Apakah pesongan raksa di dalam tolok perbezaan.

Vessels A and B contain water pressure of 275kPa and 140kPa respectively as shown in Figure 1[a]. What is the deflection of the mercury in the differential gauge?

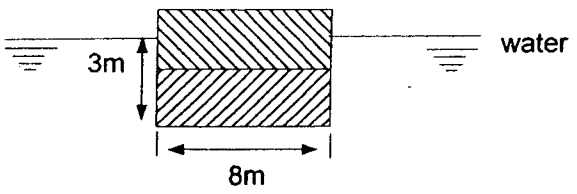


Rajah 1[a]
Figure 1[a]

(30 markah)

[b] Tongkang seperti yang ditunjukkan dalam Rajah 1[b] dibebankan supaya pusat graviti tongkang dan beban pada paras permukaan air. Adakah tongkang itu stabil?

The barge shown in Figure 1[b] is loaded such that the center of gravity of the barge and the load is at the waterline. Is the barge stable?



Rajah 1[b]
Figure 1[b]

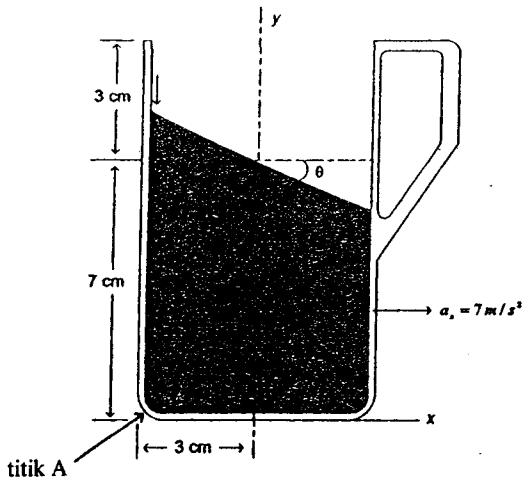
(30 markah)

[c] Pelumba seretan meletakkan kole di atas sebuah dulang mengufuk sedangkan dia memecut pada kadar $7m/s^2$ seperti yang ditunjukkan dalam Rajah 1[c]. Kole mempunyai kedalaman 10cm dan bergaris pusat 6cm dan mengandungi kopi kedalaman 7cm pada keadaan rehat.

A drag racer rests her coffee mug on a horizontal tray while she accelerates at $7m/s^2$ as shown in Figure 1[c]. The mug is 10cm deep and 6cm in diameter and contains coffee 7cm deep at rest.

(i) Anggapkan pecutan jasad tegar bagi kopi, tentukan samada kopi tertumpah keluar daripada kole.
Assuming rigid body acceleration of the coffee, determine whether it will spill out the mug.

(ii) Kirakan tekanan tolok pada bucu di titik A jika ketumpatan kopi ialah $1010kg/m^3$.
Calculate the gauge pressure in the corner at point A if the density of coffee is $1010kg/m^3$.



Rajah 1[c]
Figure 1[c]

(40 markah)

5. [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)

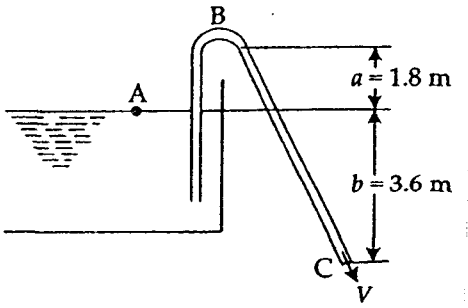
[b] Terbitkan persamaan Bernoulli bagi aliran bendalir tak boleh mampat tanpa geseran berdasarkan keabadian momentum.

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

(30 markah)

[c] Sebuah sifon mempunyai lubang bergaris pusat 75mm dan terdiri daripada paip lengkok dengan lengkokan 1.8m di atas aras air meluah ke atmosfera pada aras 3.6m di bawah paras air (Rajah 2). Tentukan halaju, luahan dan tekanan mutlak dilengkokan jika tekanan atmosfera adalah bersamaan 10m air. Abaikan kehilangan disebabkan geseran.

A siphon has a uniform circular bore of 75mm diameter and consists of a bent pipe with its crest 1.8m above water level discharging into the atmosphere at a level 3.6m below water level (Figure 2). Find the velocity, the discharge and the absolute pressure at crest level if the atmospheric pressure is equivalent to 10m of water. Neglect losses due to friction.



Rajah 2
Figure 2

(40 markah)

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6. [a] Bezakan perkara-perkara berikut dengan memberikan contoh:

Differentiate the following with examples:

(i) Aliran mampat dan aliran tak mampat.
Compressible and incompressible flows.

(ii) Bendalir Newton dan bukan Newton.
Newtonian and non-Newtonian fluids.

(iii) Aliran mantap dan tak mantap.
Steady and unsteady flow.

(iv) Aliran lamina dan gelora.
Laminar and turbulent flow.

(30 markah)

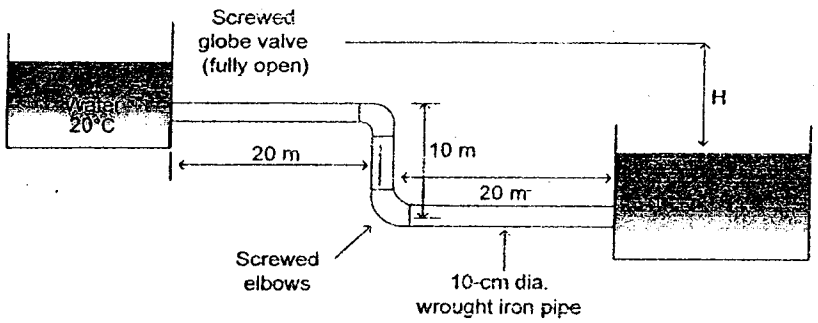
[b] Apakah kehilangan geseran dan kehilangan kecil di dalam paip? Berdasarkan apakah faktor geseran bergantung bagi 'paip licin'? Berikan contoh-contoh paip licin.

What are friction and minor losses in pipes? On what does friction factor depend for 'smooth pipes'? Give examples of such pipes.

(20 markah)

[c] Minyak akan dipindahkan daripada tangki dibahagian atas ke tangki dibahagian bawah pada kadar $0.03m^3/s$ seperti yang ditunjukkan dalam Rajah 3. Tentukan aras H bagi tangki-tangki tersebut. (Ambil ketumpatan minyak sebagai $980kg/m^3$ dan kelikatan dinamik sebagai $0.02Ns/m^2$).

The oil will be transported from the upper reservoir to the lower reservoir at a rate of $0.03m^3/s$ as shown in Figure 3. Determine the difference in elevation H of the reservoirs. (Take the oil density as $980kg/m^3$ and dynamic viscosity as $0.02Ns/m^2$).



Rajah 3
Figure 3

(50 markah)

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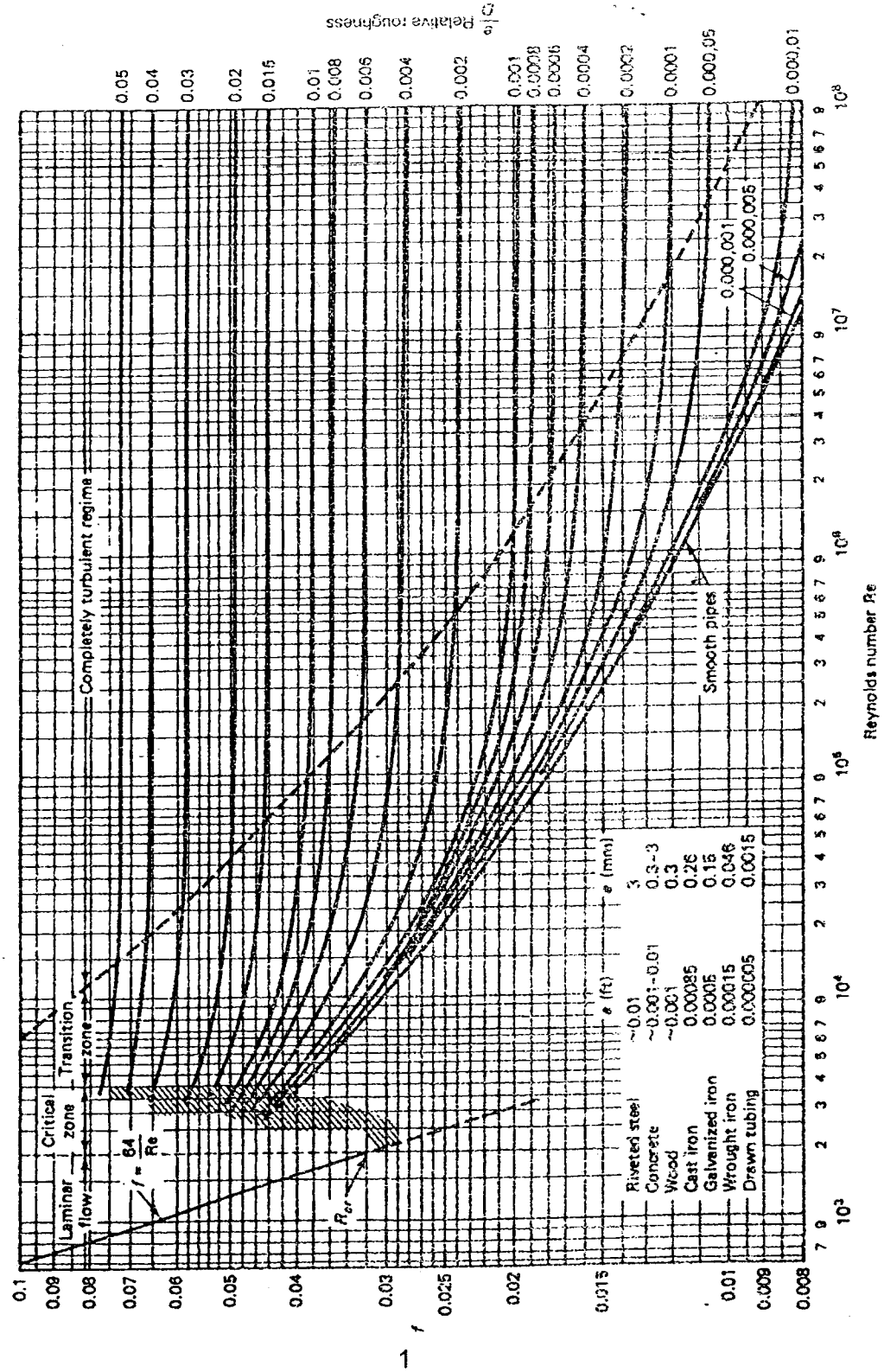
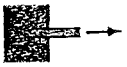
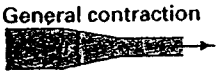

Relative roughness $\frac{e}{D}$
0.05
0.04
0.03
0.02
0.015
0.01
0.008
0.006
0.004
0.002
0.001
0.0008
0.0006
0.0004
0.0002
0.0001
0.00005
0.000001
0.000005
0.00001
Completely turbulent regime
Critical zone
Transition zone
Laminar flow
$f = \frac{64}{Re}$
R_{cr}
Smooth pipes
Reynolds number Re
10^3
10^4
10^5
10^6
10^7
10^8
f
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.025
0.02
0.015
0.01
0.009
0.008
e (ft)
e (mm)
Riveted steel ~0.01 3
Concrete ~0.001–0.01 0.3–3
Wood ~0.001 0.3
Cast iron 0.00085 0.26
Galvanized iron 0.0005 0.15
Wrought iron 0.00015 0.046
Drawn tubing 0.000005 0.0015

Type of fitting	Screwed			Flanged		
Diameter	1 in.	2 in.	4 in.	2 in.	4 in.	8 in.
Globe valve (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	.95	.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			
Sudden contraction[b] 	Area ratio					
	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[c] 			$\left(1 - \frac{A_1}{A_2}\right)^2$			
90° miter bend (without vanes) 			1.1			
(with vanes) 			0.2			
General contraction 	(30° included angle)		0.02			
	(70° included angle)		0.07			

[a]Values for other geometries can be found in *Technical Paper 410*, The Crane Company, 1957.
[b]Based on exit velocity V_2.
[c]Based on entrance velocity V_1.