UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2007/2008

October/November 2007

EEM 223 – THERMOFLUIDS
[Termobendalir]

Duration: 3 hours
[Masa: 3 jam]

Please check that this examination paper consists of EIGHT pages of printed material and TWO pages APPENDIX before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi LAPAN muka surat bercetak dan DUA muka surat LAMPIRAN sebelum anda memulakan peperiksaan ini].

This paper contains SIX questions.

[Kertas soalan ini mengandungi ENAM soalan].

Instructions: Answer **FIVE** (5) questions. If a candidate answer more than five questions, only the first five answered will be examined and awarded marks.

*[**Arahan:** Jawab **LIMA** soalan. 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].

...2/-

1. (a) Nyatakan tenaga yang merentasi sempadan bagi sebuah sistem tertutup.

State the energy that can cross the boundaries of a closed system.

(20 markah)

(b) Terangkan proses adiabatik dan berikan beberapa contoh.

Explain an adiabatic process and give some examples. (30 markah)

(c) Gas dimampatkan daripada isipadu awal 0.42 m^3 kepada isipadu akhir 0.12 m^3, perubahan tekanan dengan isipadu mengikut hubungan $P = aV + b$, disini $a = -1200$ kPa/m^3 dan $b = 600$ kPa.

A gas is compressed from an initial volume of 0.42 m^3 to a final volume of 0.12 m^3, the pressure changes with volume according to the relation $P = aV + b$, where $a = -1200$ kPa/m^3 and $b = 600$ kPa.

(i) Lakarkan proses pada rajah P-V

Plot the process on a P-V diagram

(ii) Kirakan kerja yang dilakukan semasa proses

Calculate the work done during the process (50 markah)

2. (a) Terangkan ungkapan wap tepu, wap panas lampau dan pecahan kekeringan.

Explain the terms saturated steam, superheated steam and dryness fraction.

(30 markah)

(b) Terangkan pentingnya menetapkan wap kering dan terangkan bagaimana ianya boleh dilakukan secara praktik.

Describe the importance of keeping the steam dry and explain how this is achieved in practice.

(30 markah)

...3/-

(c) Jisim 5 kg wap basah di dalam sebuah peralatan omboh-silinder pada 100 kPa. Pada awalnya, 2 kg air yang berkeadaan cecair dan selebihnya dalam fasa wap. Haba dipindahkan kepada air dan omboh di atas penahan mula bergerak apabila tekanan dalaman mencapai 200 kPa. Haba dibekal sehingga jumlah isipadu meningkat sebanyak 20%. Tentukan:

A mass of 5 kg of wet steam is contained in a piston-cylinder device at 100 kPa. Initially, 2 kg of the water is in the liquid phase and the rest is the vapour phase. Heat is now transferred to the water, and the piston, which is resting on a set of stops, starts moving when the pressure inside reaches 200 kPa. Heat continues until the total volume increases by 20%. Determine:

(i) Suhu awal dan akhir.

The initial and final temperatures.

(ii) Jisim cecair apabila omboh mula bergerak.

The mass of liquid when the piston first starts moving.

(iii) Kerja terhasil semasa proses.

The work done during the process.

(40 markah)

3. (a) Sebuah sistem telah melalui proses di antara pada mulanya berkeadaan tetap yang boleh-balik dan selepas melalui proses tak boleh-balik. Terangkan perubahan entropi bagi kedua-dua proses tersebut.

A system undergoes a process between fixed states first in a reversible manner and then in an irreversible manner. Explain the entropy changes for both processes.

(40 markah)

(b) Wap memasuki sebuah turbin adiabatic secara mantap pada 3MPa dan 400°C dan meninggalkan turbin pada 50kPa dan 100°C. Kuasa keluaran turbin ialah 2MW, tentukan:

Steam enters an adiabatic turbine steadily at 3MPa and 400°C and leaves at 50kPa and 100°C. The power output of the turbine is 2MW, determine:

(i) Kecekapan isentropic bagi turbin.

The isentropic efficiency of the turbine.

(ii) Kadar aliran jisim bagi wap.

The mass flow rate of the steam.

(60 markah)

4. (a) Terangkan mengapa pemalar kelikatan meningkat dengan peningkatan suhu bagi gas dan berkurangan dengan suhu bagi cecair.

Explain why does coefficient of viscosity increase with increase in temperature for gases and decrease with increase in temperature for liquid.

(20 markah)

(b) Sebuah tiub garis pusat kecil dimasukkan ke dalam cecair yang mempunyai sudut sentuh 110°. Adakah paras cecair di dalam tiub akan meningkat atau menurun? Terangkan.

A small diameter tube is inserted into a liquid whose contact angle is 110°. Will the level of liquid in the tube rise or drop? Explain.

(30 markah)

(c) Alat yang ditunjukkan dalam Rajah 4(c) mengandungi sebuah cakera yang diputarkan oleh sebuah aci. Cakera diletakkan amat dekat dengan permukaan pepejal. Di antara cakera dan sempadan adalah minyak likat.

The device as shown in Figure 4(c) consists of a disk that is rotated by a shaft. The disk is positioned very close to a solid boundary. Between the disk and the boundary is viscous oil.

(i) cakera diputarkan pada kadar 1 rad/s, tentukan nisbah tegasan ricih di dalam minyak pada r = 2 cm kepada tegasan ricih pada r = 3 cm.

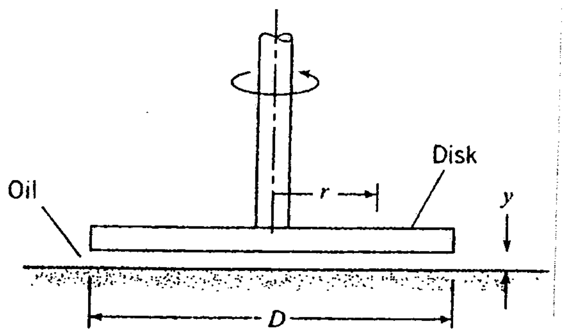
the disk is rotated at a rate of 1 rad/s, determine the ratio of the shear stress in the oil at r = 2 cm to the shear stress at r = 3 cm.

(ii) kadar putaran ialah 2 rad/s, kirakan halaju bagi minyak bersentuhan dengan cakera pada r = 3 cm.

the rate of rotation is 2 rad/s, calculate the speed of the oil in contact with the disk at r = 3 cm.

(iii) kelikatan adalah 0.01 Ns/m^2 dan jarak y ialah 2 mm, tentukan tegasan ricih pada keadaan S4[c](ii).

the viscosity is 0.01 Ns/m^2 and the spacing y is 2 mm, determine the shear stress for the conditions in Q4[c](ii).



Rajah 4(c)
Figure 4(c)

(50 markah)

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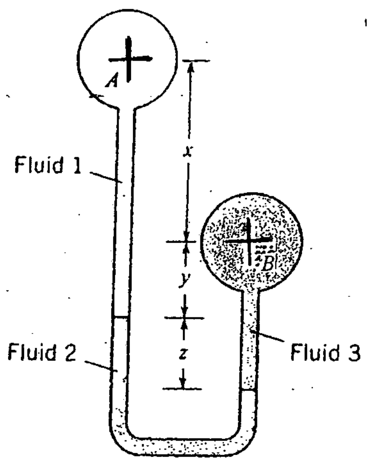
5. (a) Lakar dan terangkan penggunaan piezometer atau manometer bagi mengukur keamatan tekanan dalam cecair.

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

(30 markah)

(b) Tentukan perbezaan tekanan P_A-P_B bagi nilai-nilai x = 3.0 m, y = 1.0 m, z= 2.0 m, dan bendalir 1, 2 dan 3 masing-masing adalah kerosin, air dan kerosin dalam Rajah 5(b). Anggapkan graviti tentu bagi kerosin ialah 0.8.

Determine the pressure difference P_A-P_B for the values of x= 3.0 m, y= 1.0 m, z= 2.0 m, and the fluids 1, 2 and 3 are kerosene, water, and kerosene respectively in Figure 5(b). Assume the specific gravity of kerosene is 0.8.

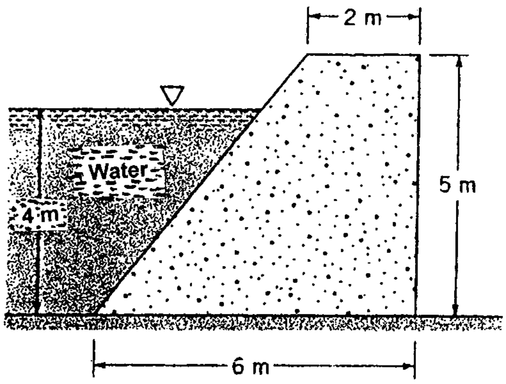


Rajah 5(b)
Figure 5(b)

(30 markah)

(c) Empangan konkrit dalam Rajah 5(c) mempunyai berat 23.6 kN/m^3 dan diletakkan di atas dasar pepejal. Tentukan pemalar minimum geseran di antara empangan dan dasar yang dikehendaki bagi menetapkan empangan daripada tergelincir pada kedalaman air yang ditunjukkan. Anggapkan tiada tekanan angkat bendalir disepanjang dasar.

The concrete dam of Figure 5(c) weighs 23.6 kN/m^3 and rests on a solid foundation. Determine the minimum coefficient of friction between the dam and the foundation required to keep the dam from sliding at the water depth shown. Assume no fluid uplift pressure along the base.



Rajah 5(c)
Figure 5(c)

(40 markah)

6. (a) Lakar dan terangkan penggunaan tiub pitot-statik bagi mengukur aliran bendalir.

Sketch and explain the use of a pitot-static tube to measure the point velocity of flow field.

(30 markah)

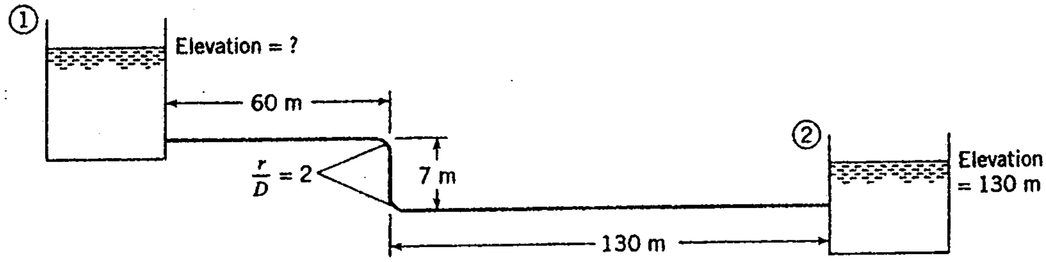
(b) Kerosin dengan kelikatan kinematik 2×10^{-6} m^2/s dan graviti tentu 0.8 mengalir di dalam sebuah paip 15 cm pada kadar 0.02 m^3/s. Kirakan kehilangan turus per 100 m panjang paip.

Kerosene with a kinematic viscosity of 2×10^{-6} m^2/s and specific gravity of 0.8 flows in a 15 cm pipe at a rate of 0.02 m^3/s. Calculate the head loss per 100 m of length of pipe.

(30 markah)

(c) Minyak mengalir daripada tangki atas kepada tangki bawah pada kadar 0.028 m^3/s di dalam paip licin seperti dalam Rajah 6(c). Tentukan aras permukaan minyak pada tangki atas. (Ambil kelikatan minyak adalah 4×10^{-5} m^2/s dan graviti tentu adalah 0.9). (Rujuk Lampiran A & B).

The oil flows from the upper to the lower reservoir at a rate of 0.028 m^3/s in the smooth pipe as shown in Figure 6(c). Determine the elevation of the oil surface in the upper reservoir. (Take the kinematic viscosity of oil is 4×10^{-5} m^2/s and specific gravity of 0.9). (Refer Appendices A & B).



Rajah 6(c)
Figure 6(c)

(40 markah)

- oooOooo -

Gambarajah Moody

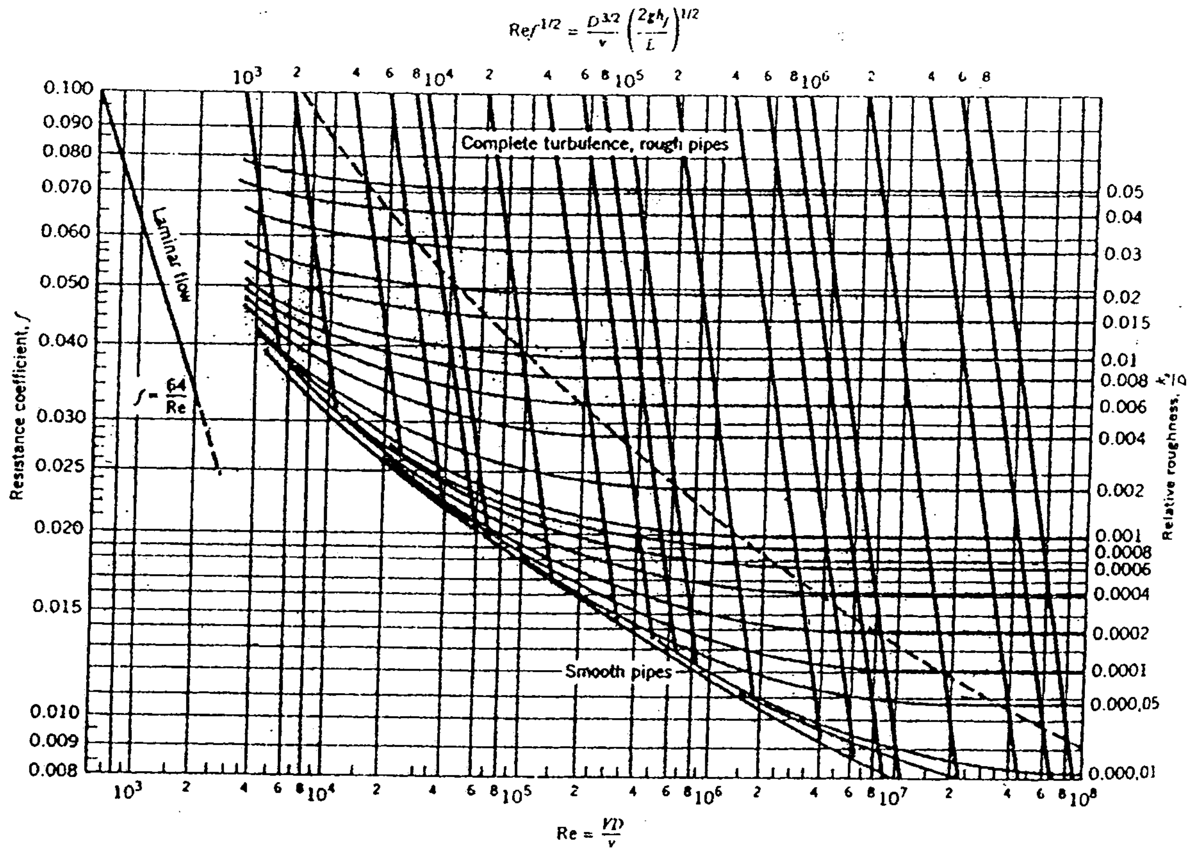


FIGURE 10.8

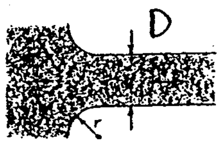
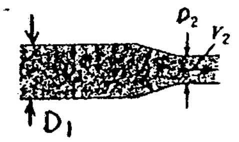
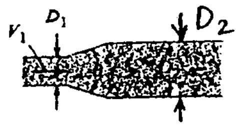
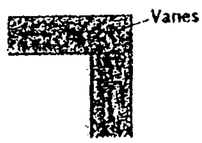
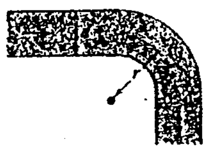
Resistance coefficient f versus Re. Reprinted with minor variations. [After Moody (31). Reprinted with permission from the A.S.M.E.]

TABLE 10.2 EQUIVALENT SAND GRAIN ROUGHNESS FOR VARIOUS PIPE MATERIAL

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

Pemalar Kehilangan pada Pelbagai Sambungan

[illegible]

Description	Sketch	Additional Data		K	Source
Pipe entrance		r/D		K_e	(2)*
		0.0		0.50	
		0.1		0.12	
$h_L = K_e V^2/2g$		>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	$K_b = 0.4$			