UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2011/2012

January 2012

EBS 238/3 – Fluid Mechanics
[Mekanik Bendalir]

Duration : 3 hours
[Masa : 3 jam]

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

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

Instruction: 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 questions answered in the answer script would be examined.
*[**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.]*

The answers to all questions must start on a new page.
[Mulakan jawapan anda untuk semua 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.]

In the event of any discrepancies, the English version shall be used.
[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

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PART A / *BAHAGIAN A*

1. [a] Determine the horizontal and vertical component of the force acting on the radial gate ABC in Figure 1 and their line of action. What is the force F required to open the gate (neglecting the weight of the gate)?

Tentukan komponen mendatar dan menegak daya yang untuk bertindak pada get jejari ABC dalam Rajah 1 dan tunjukkan arah tindakan. Apakah daya F yang diperlukan untuk membuka get (abaikan berat get)?

(25 marks/*markah*)

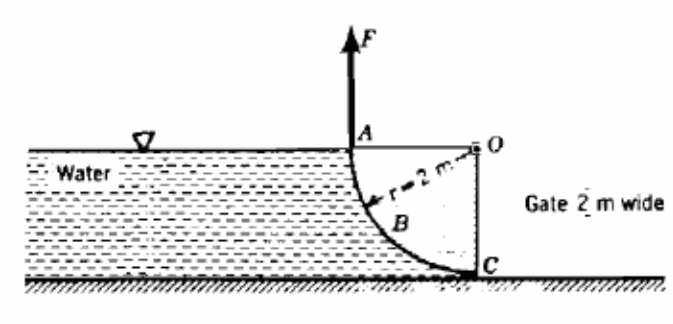

Figure 1/ Rajah 1

[b] In Figure 2, the gate AB is 5 ft wide and open to let fresh water out when the ocean tide is dropping. The hinge at A is 2 ft above the fresh water level. At what ocean level height, h will the gate open? Neglect the gate weight.

Dalam Rajah 2, get AB mempunyai luas 5 ft akan terbuka untuk membiarkan air tawar mengalir apabila arus lautan berkurang. Engsel di A adalah 2 ft di atas paras air tawar. Apakah tahap ketinggian, h pintu akan terbuka? Abaikan berat get.

(25 marks/*markah*)

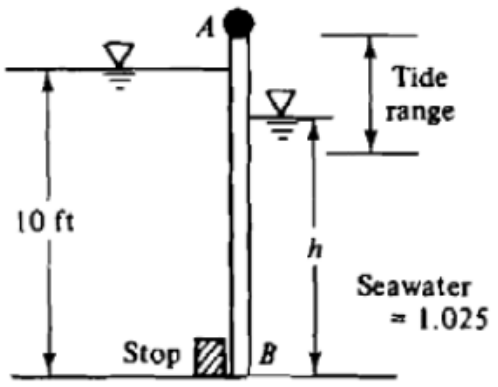

Figure 2 / Rajah 2

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[c] What is the weight of barge and load in Figure 3? The barge is 6 m in width.

Apakah berat tongkang dan beban dalam Rajah 3? Tongkang adalah 6 m lebar.

(25 marks/*markah*)

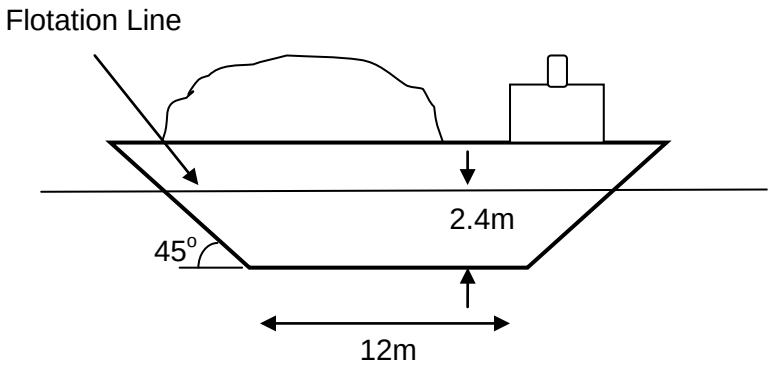

Figure 3 / Rajah 3

[d] The venturi meter shown reduces the pipe diameter from 10 cm to a minimum of 5 cm. Calculate the flow rate and the mass flux (mass flow rate) assuming ideal condition.

Meter venturi yang ditunjukkan mengurangkan garis pusat paip dari 10 cm kepada sekurang-kurangnya 5 cm. Kira kadar aliran dan fluks jisim (kadar aliran jisim) dengan menganggap keadaan yang ideal.

(25 marks/*markah*)

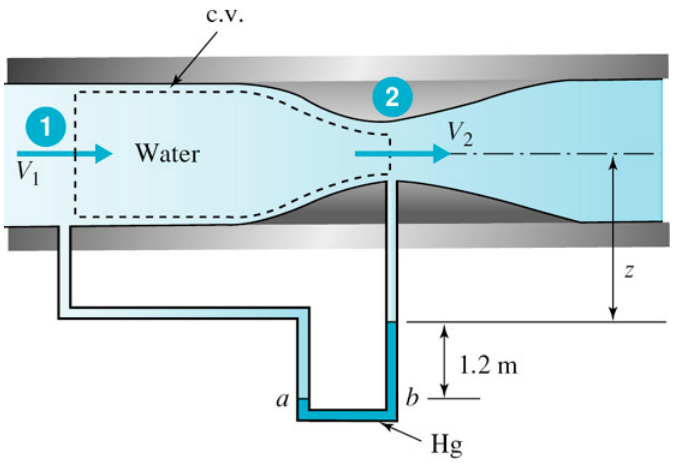

Figure 4 / Rajah 4

2. [a] A 45^o reducing bend (Figure 5), 0.6 m diameter upstream, 0.3 m diameter downstream, has water flowing through it at the rate of 0.45 m^3/s under a pressure of 1.45 bar. Neglecting any head loss for friction; calculate the force exerted by the water on the bend, and its direction of application.

Sebuah liku pengurangan (Rajah 5) bersudut 45^o, mempunyai diameter 0.6 m pada hulu aliran dan diameter 0.3 m di hilir aliran, mempunyai air yang mengalir pada kadar 0.45 m^3/s di bawah tekanan 1.45 bar. Abaikan kehilangan turus bagi geseran, kirakan daya yang dikenakan oleh air pada liku, dan arah daya tersebut bertindak.

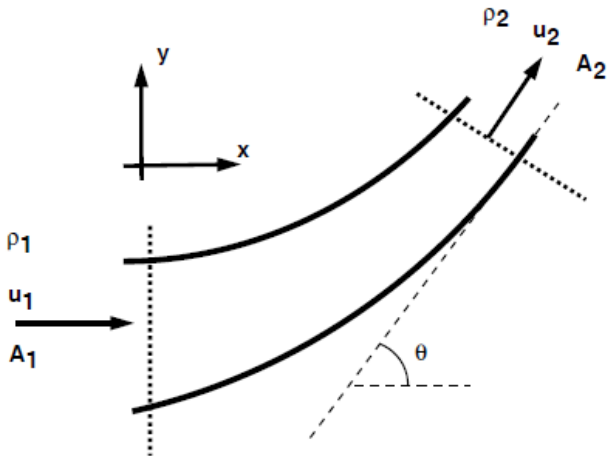

Figure 5 / Rajah 5

(70 marks/*markah*)

[b] Explain the following fluid flow (with the aid of diagrams, where necessary):

(i) steady uniform flow

(ii) unsteady non-uniform flow

(iii) compressible and incompressible flow

(iv) streamline and stream tube

Dengan bantuan gambarajah, terangkan keadaan aliran bendalir berikut:

(i) aliran mantap seragam

(ii) aliran tidak mantap tidak seragam

(iii) aliran mampat dan tidak mampat

(iv) garis arus dan tiub arus

(30 marks/*markah*)

…5/-

3. [a] Assume ideal fluid. The pressure at section 1 in Figure 6 is 68.95 kPa, V_1 = 4.572 m/s, V_2 = 15.24 m/s, and γ = 961.1 kg/m^3. (i) Determine the reading on the manometer. (ii) If the downstream piezometer were replaced with a pitot tube, what would be the manometer reading?

Anggap bendalir unggul. Tekanan di seksyen 1 dalam Rajah 6 ialah 68.95 kPa, V_1 = 4.572 m/s, V_2 = 15.24 m/s, dan γ = 961.1 kg/m^3. (i) Tentukan bacaan pada manometer. (ii) Jika piezometer hiliran telah digantikan dengan tiub pitot, apa yang akan menjadi bacaan manometer?

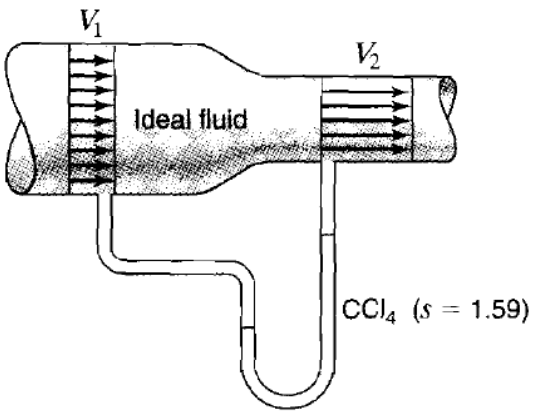

Figure 6 / Rajah 6

(30 marks/*markah*)

[b] In Figure 7 friction loss between A and B is negligible while between B and C the loss is 0.15 ($0.15V_B^2/2g$). Given h = 750 mm, diameter A and C is 250 mm, diameter B = 100 mm. Find the pressure heads at A and C if the liquid is flowing through the circular pipe from A to C at the rate of 280 L/s.

Kehilangan geseran pada Rajah 7 antara A dan B boleh diabaikan sementara di antara B dan C kehilangan adalah ($0.15V_B^2/2g$). *Diberi h = 750 mm, diameter A and C ialah 250 mm, diameter B = 100 mm. Kirakan turus tekanan di C dan A jika cecair yang mengalir melalui paip bulat dari A ke C ialah pada kadar 280 L/s.*

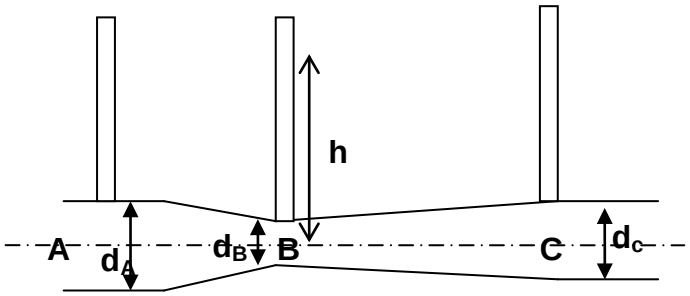

Figure 7 / Rajah 7

(35 marks/*markah*)

[c] A pump draw water from a sump through a vertical 0.1524 m pipe. The pump has a horizontal discharge pipe 0.1016 m in diameter that is 3.23 m above the water level in the sump while pumping 0.0354 m^3; gages near the pump at entrance and discharge read -31.72 kPa and +176.5 kPa respectively. The discharge gage is 0.914 m above the suction gage. Compute the horsepower output of the pump and the head lost in the 0.1524 m suction pipe.

Sebuah pam mengambil air dari takungan melalui paip tegak 0.1524 m. Pam tersebut mempunyai paip mendatar 0.1016 m diameter yang berada 3.23 m di atas paras air dalam takungan sambil mengepam pada kadar 0.0354 m^3; tolok tekanan pada pintu masuk dan keluar pintu masuk menunjukkan bacaan -31.72 kPa dan + 176.5 kPa masing-masing. Tolok pintu keluar berada pada 0.914 m di atas tolok sedutan. Kira kuasa output kuda pam dan kehilangan turus dalam paip 0.1524 m tersebut.

(35 marks/*markah*)

4. [a] Explain the difference between pump and turbines in terms of energy transfers.

Terangkan perbezaan di antara sebuah pam dan turbin dari segi pemindahan tenaga.

(20 marks/*markah*)

[b] Neglect viscous effect, assume uniform velocity profiles and find the horizontal force component acting on the obstruction shown in Figure 8. (Given: γ_{water} = 9810 N/m^3)

Dengan mengabaikan kesan kelikatan dan menganggap profil kelajuan seragam, dapatkan komponen daya mengufuk yang bertindak pada halangan yang ditunjukkan dalam Rajah 8. (Diberi: γ_{air} = 9810 N/m^3)

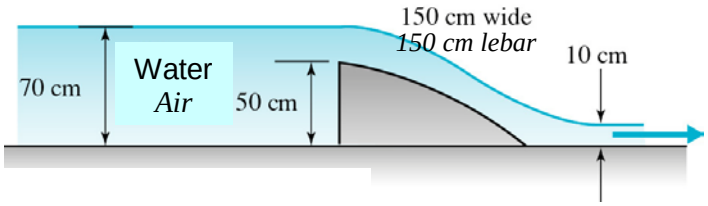

Figure 8 / Rajah 8

(40 marks/*markah*)

[c] Referring to Figure 9, assume the tube flows full and all friction losses are negligible. The diameter at B is 60 mm and the diameter of jet discharging into the air is 80 mm. If h = 5 m, what is the flow rate? What is the pressure head at B? What is the flow rate? What would be the flow rate if the tube were cut off at B?

Merujuk kepada Rajah 9, dengan menganggap tiub aliran penuh dan semua kehilangan geseran diabaikan. Garis pusat di B ialah 60 mm dan diameter jet menujah ke udara ialah 80 mm. Jika h = 5 m, dapatkan kadar alirannya? Apakah turus tekanan di B? Apakah kadar aliran? Apa yang akan kadar aliran jika tiub terputus di B?

(40 marks/*markah*)

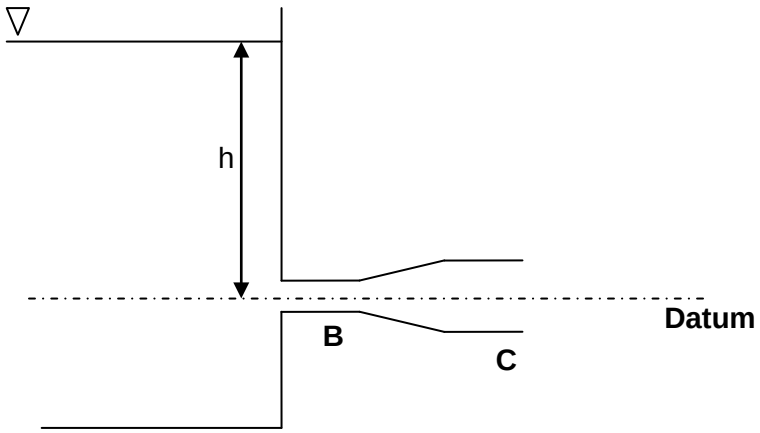

Figure 9 / Rajah 9

PART B / *BAHAGIAN B*

5. Determine the energy loss if glycerine at 25°C flows 30 m through 150-mm-diameter pipe with an average velocity of 4.0 m/s. Density, ρ and dynamic viscosity, μ of glycerin are given as 1258 kg/m^3 and 9.6 x 10^{-1} Pa•s respectively.

Hitungkan kehilangan tenaga jika glycerine pada 25°C mengalir 30 m melalui paip berdiameter 150-mm dengan halaju 4.0 m/s. Ketumpatan, ρ dan kelikatan dinamik, μ glycerin diberi sebagai 1258 kg/m^3 and 9.6 x 10^{-1} Pa•s masing-masing.

(100 marks/*markah*)

6. [a] Name the 4 combinations of free-surface flow classification.

Namakan 4 klasifikasi aliran permukaan bebas.

(20 marks/*markah*)

[b] Water is flowing in a triangular channel with $m_1 = m_2 = 1.0$ at a discharge of Q = 3 m^3/s. If the water depth is 2.5 m, determine the specific energy, Froude number, and hydraulic depth.

Air mengalir dalam channel segitiga dengan $m_1 = m_2 = 1.0$ pada discaj Q = 3 m^3/s. Jika kedalaman air adalah 2.5 m, hitungkan tenaga spesifik, nombor Froude, dan kedalaman hidrolik.

(80 marks/*markah*)

7. Gasoline is being pumped at 400 L/s in a pipeline from location A to B as shown in Figure 10. The pipe follows the topology as shown, with the highest elevation shown at location C. The only contributions to minor losses are the two valves located at the ends of the pipe. If S = 0.81, v = 4.26 x 10^{-7} m^2/s, p_v = 55.2 kPa absolute and p_{atm} = 100 kPa, then:

Gasolin dipam pada 400 L/s dalam lingkaran paip dari lokasi A ke B seperti ditunjukkan dalam Rajah 10. Paip didapati mengikut topologi seperti ditunjukkan, dengan ketinggian tertinggi di lokasi C. Kehilangan minor yang hanya didapati adalah 2 valve pada hujung paip. Jika S = 0.81, v = 4.26 x 10^{-7} m^2/s, p_v = 55.2 kPa absolute and p_{atm} = 100 kPa, maka:

(a) Determine the necessary power to be delivered to the system to meet the flow requirement.

Hitungkan kuasa yang perlu dihantar ke sistem untuk memenuhi keperluan aliran.

(65 marks/*markah*)

(b) What is the maximum elevation possible at location C without causing vapor pressure conditions to exist?

Ketinggian maksimum yang mungkin pada lokasi C tanpa menyebabkan kewujudan syarat tekanan wap.

(35 marks/*markah*)

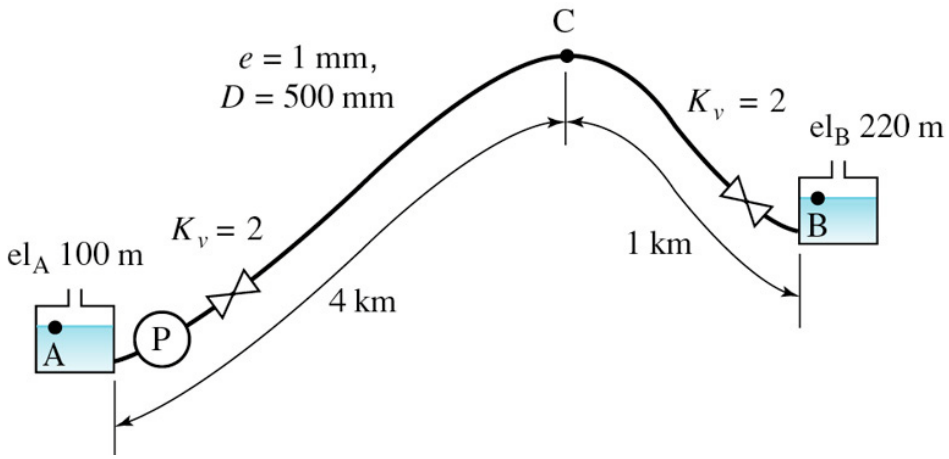

Figure 10 / Rajah 10

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APPENDIX 1

LAMPIRAN 1

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

Sifat-Sifat Bendalir Biasa pada Tekanan Atmosfera dan Suhu Anggaran 16° to 21°C

TABLE B.5 Properties of Common Liquids at Atmospheric Pressure and Approximately 60 to 70°F (16 to 21°C)

	Specific weight γ		*Density* ρ		*Surface tension*[a] σ		*Vapor pressure* p_v	
Liquid	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.

APPENDIX 2

LAMPIRAN 2