UNIVERSITI SAINS MALAYSIA

First Semester Examination
2007/2008 Academic Session

October / November 2007

EAH 221/3 – Fluid Mechanics for Civil Engineers
[Mekanik Bendalir Untuk Jurutera Awam]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **TEN** pages of printed material including appendix before you begin the examination.
*[Sila pastikan kertas peperiksaan ini mengandungi **SEPULUH** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions: Answer **FIVE** (5) questions only. All questions carry the same marks.
*[Arahan: Jawab **LIMA** (5) soalan sahaja. Semua soalan membawa jumlah markah yang sama.]*

You may answer the question either in Bahasa Malaysia or English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

All questions **MUST BE** answered on a new sheet.
*[Semua jawapan **MESTILAH** dijawab pada muka surat baru.]*

Write the answered question numbers on the cover sheet of the answer script.
[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]

1. (a) Consider the sluice gate shown in Figure 1. The gate has a width of 8 m.

[i] Determine the magnitude of the horizontal restraining force required to hold the gate in placed for the indicated flow conditions.

[ii] What is the magnitude of the horizontal restraining force required to hold the gate in placed when it is closed and the up-stream water depth is 4 m?

(14 marks)

Pintu sluis ditunjukkan dalam Rajah 1. Lebar pintu sluis bersamaan dengan 8 m.

[i] Tentukan magnitud daya mengufuk untuk mengekalkan pintu sluis pada posisi dan keadaan aliran yang diberikan.

[ii] Tentukan mengnitud daya tahanan yang diperlukan untuk mengekalkan pintu sluis pada posisi semasa ianya ditutup dan kedalaman 4 m.

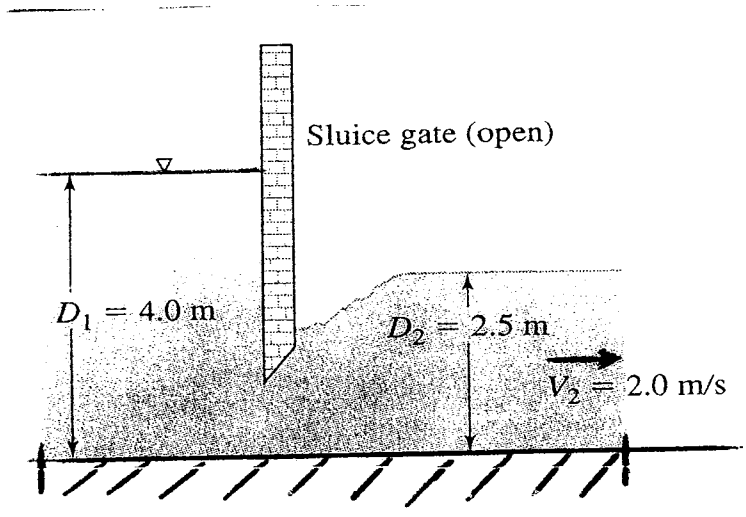


Figure 1

1. (b) Oil (SG = 0.85) is drained through the siphon (D = 50 mm) shown in Figure 2. What is the volume flowrate and mass flowrates?

(6 marks)

Minyak (GT = 0.85) dialirkan melalui sifon (D = 50 mm) seperti di Rajah 2. Tentukan isipadu dan jisim kadar alir.

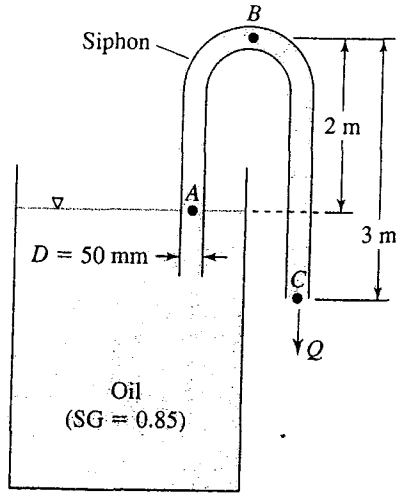


Figure 2

2 (a) A flow condition known as a hydraulic jump as illustrated in Figure 3. Let the upstream water height be D_1 and the upstream velocity be V_1. Use the continuity and momentum equations to derive expressions for the downstream water height, D_2, and downstream velocity, V_2. Be sure to state any assumptions.

(12 marks)

Sebuah lompatan hidraulik dilakarkan seperti Rajah 3. Dengan mengunakan persamaan keselanjaran dan momentum, terbitkan persamaan bagi bahagian hilir lompatan tersebut. Tentukan andaian yang digunapakai.

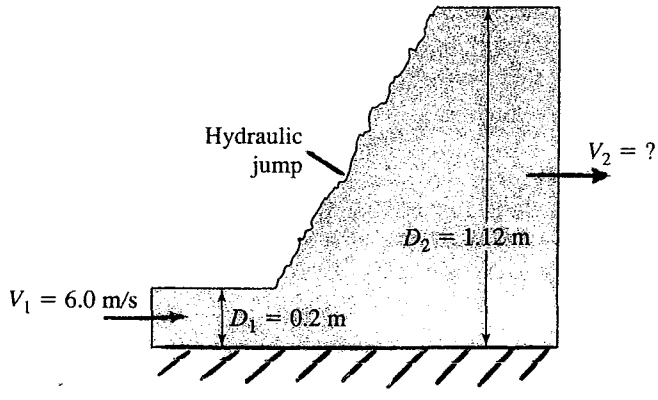


Figure 3

2 (b) A plan flow geometry shown in Figure 4. The two (2) input streams are equal in velocity. The horizontal stream is water and the vertical stream is oil (890 kg/m^3). Determine the velocity in term of magnitude and vector of the exist stream.

(8 marks)

Dua (2) kadar alir masuk mempunyai kelajuan yang sama. Arus mengufuk adalah air dan arus menegak adalah minyak (890 kg/m^3). Tentukan halaju dalam bentuk magnitud dan vektor untuk arus keluar.

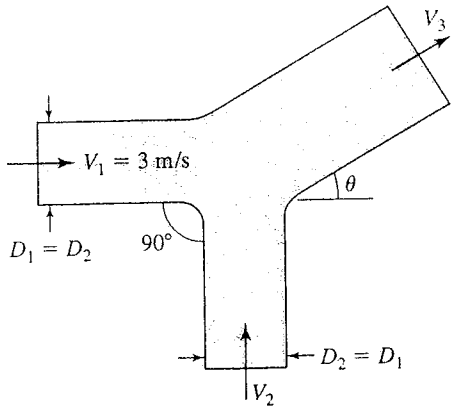


Figure 4

3. (a) The water tank system shown in Figure 5 is in steady state; find the water depth in the second tank H_2. (Note H_1= 1.5 m, D_1 = 50mm and D_2 = 25mm)

(5 marks)

Sistem tangki seperti di Rajah 5 adalah dalam keadaan mantap. Tentukan ketinggian air untuk tangki kedua (H_2).

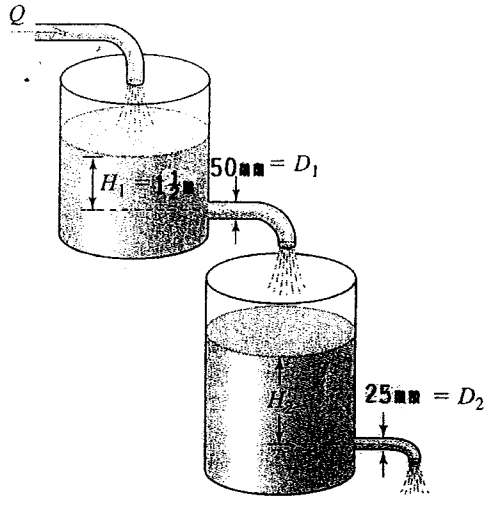


Figure 5

3. (b) The spillway shown in Figure 6 is 5 m wide. Determine the volume and mass flowrates in the channel.

(5 marks)

Sebuah alur limpah seperti di Rajah 6 mempunyai kelebaran 5 m. Tentukan isipadu dan jisim kadar alir untuk terusan tersebut.

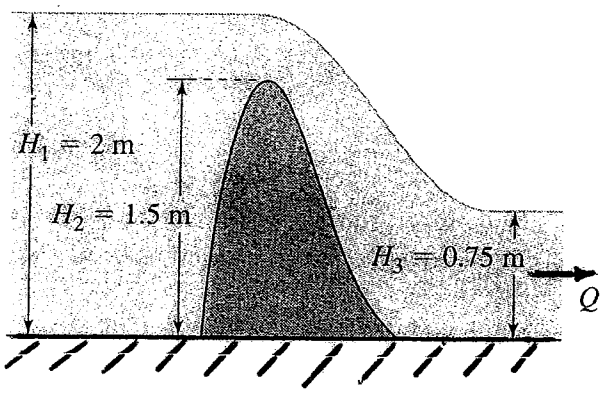


Figure 6

(c) A bridge pier is a canal is 1 m x 2 m, as shown in Figure 7. If the flowrate is 10 m/s, what is the bending moment on the pier? Assume a uniform velocity profile.

(10 marks)

Tiang jambatan di dalam terusan berukuran 1 m x 2 m seperti di Rajah 7. Sekiranya kadar alir 10 m/s, tentukan momen lentur untuk tiang tersebut. Andaikan halaju adalah seragam.

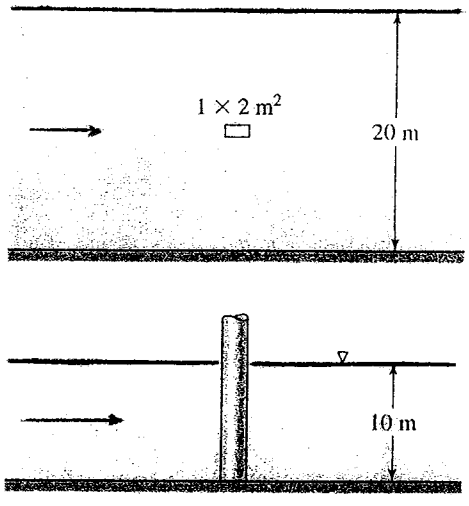


Figure 7

4. (a) A rock has a specific gravity of 2.32 and a volume of 1.43×10^{-4} m^3. How much does it weigh?

(4 marks)

Batu mempunyai graviti tentu 2.32 dan isipadu 1.43×10^{-4} m^3. Berapakah berat batu tersebut.

(b) Derive an expression for the change in height 'h' in a circular tube of liquid with surface tension σ and contact angle θ, as shown in Figure 8 below.

(10 marks)

Terbitkan persamaan untuk perubahan ketinggian 'h' untuk tiub yang mengandungi cecair dengan tegangan permukaan (σ) dan sudut (θ) seperti di Rajah 8.

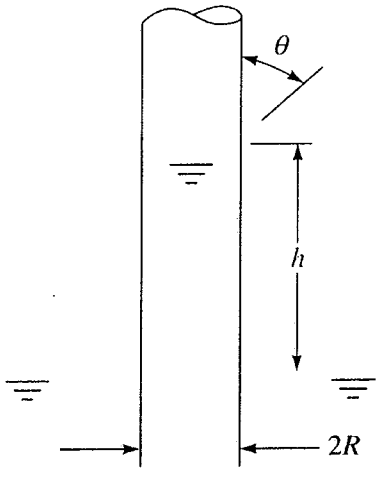


Figure 8

(c) Define the pressure, density, specific weight, specific gravity, dynamic viscosity and kinematic viscosity.

(6 marks)

Berikan definasi bagi tekanan, ketumpatan, berat tentu, graviti tentu, kelikatan dinamik dan kelikatan kinematik.

5. (a) Determine total force and location of centre of pressure in the following cases in Figure 9(a), (b) and (c).

(12 marks)

Tentukan jumlah daya dan pusat tekanan untuk kes-kes tersebut:

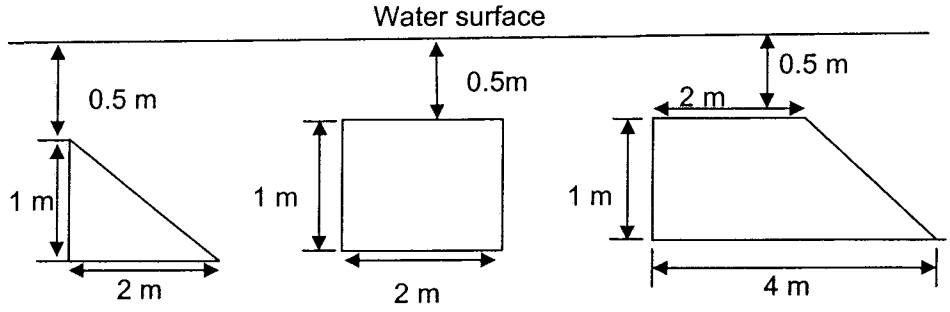


Figure 9

(b) Pressure gage B is to measure the pressure at Point A in a water flow. If the pressure at B is 87 KPa, estimate the pressure at A in KPa. Assume all fluids are at 20°C. Please see Figure 10.
Specific weight of water 9810 N/m^3; Specific weight of mercury = 133100 N/m^3; Specific weight of Oil 8720 = N/m^3.

(8 marks)

Tekanan tolok di B tentukan oleh tekanan di A. Sekiranya tekanan di B adalah 87 kPa, hitung tekanan di A.

Andaian:
(Suhu adalah 20°C, berat tentu air adalah 9810 N/m^3; berat tentu raksa 133100 N/m^3; buat tentu minyak 8720 = N/m^3.)

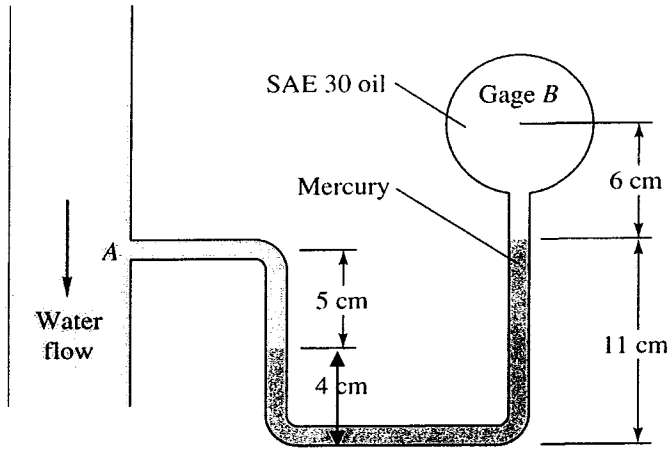


Figure 10

6. (a) A block of concrete weighs 100 lbf in air and 'weighs' only 60 lbf when immesered in fresh water (62.4 lbf/ft^3). Determine is the average specific weight of the block. (Please see Figure 11).

(8 marks)

Sebuah blok konkrit mempunyai berat 100 lbf dan berat di dalam air adalah 60 lbf ketika terendam. Cari nilai purata berat tentu bagi blok tersebut.

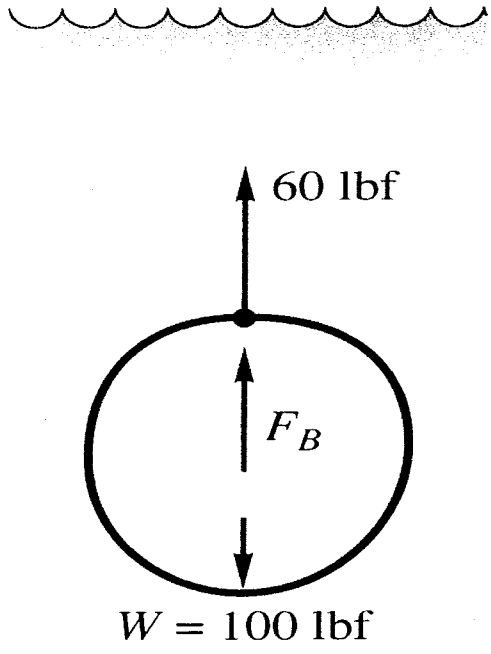


Figure 11

6. (b) A pipe diameter changes from 0.5 m to 1.0 m in a length of 1 m giving a pipe diffuser or transition. If a discharge Q (m^3/s) flows from the 0.5 m diameter section towards 1.0 m diameter section, obtain a general expression for velocity (Please see Figure 12 for pipe cross section and flow direction).

(12 marks)

Sebatang paip bertukar diameter dari 0.5 m ke 1.0 m bagi jarak 1 meter. Sekiranya kadar alir Q (m^3/s) mengalir dari keratan rentas 0.5 m ke keratan rentas 1.0 m, terbitkan persamaan halaju.

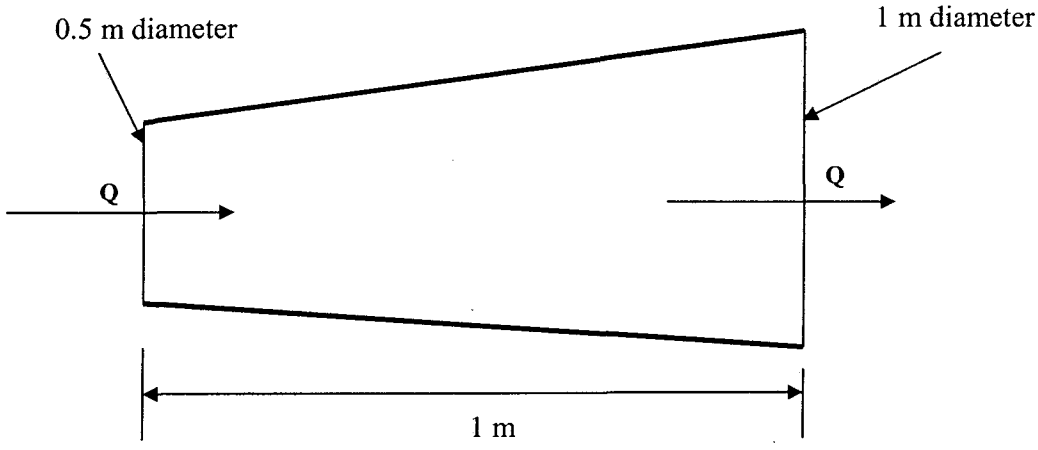
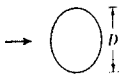
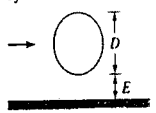
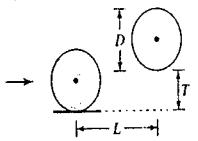
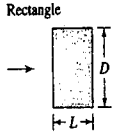
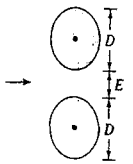
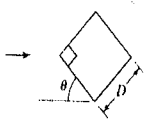
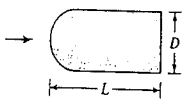
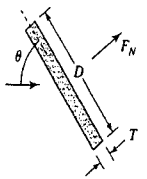
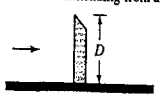
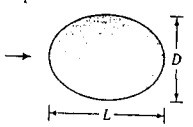


Figure 12

Geometry	Drag Coefficient, C_D, and Remarks
Circular Cylinder 	Re | 10^2 10^3 10^4 10^5 10^6 10^7 C_D | 1.4 1.0 1.1 1.2 0.4 0.8 For $Re < 1$, $C_D \approx 8\pi/[Re \log_e (7.4/Re)]$.
Cylinder Near a Wall 	E/D | C_D | C_L 0 | 0.8 | 0.6 0.25 | 1.1 | 0.25 0.5 | 1.2 | 0.15 1.0 | 1.3 | 0.05 1.5 | 1.2 | 0.02 2.0 | 1.2 | 0 4.0 | 1.2 | 0 6.0 | 1.2 | 0 $10^4 < Re < 10^5$ Lift force is away from wall.
Cylinder Downstream of Another Cylinder 	$T/D = 0$: L/D | C_D 1.0 | −0.4 1.5 | −0.2 2.0 | 0.0 2.5 | 0.2 3.0 | 0.2 4.0 | 0.3 $T/D = 0.5$: L/D | C_D 1.0 | 0.65 1.5 | 0.50 2.0 | 0.45 2.5 | 0.45 3.0 | 0.40 4.0 | 0.40
Drag on Downstream Cylinder	$T/D = 1.0$: L/D | C_D 1.0 | 1.1 1.5 | 1.0 2.0 | 0.70 2.5 | 0.70 3.0 | 0.65 4.0 | 0.65 $T/D = 2$: L/D | C_D 1.0 | 1.1 1.5 | 1.0 2.0 | 1.0 2.5 | 1.0 3.0 | 1.0 4.0 | 1.0 $10^4 < Re < 10^5$
Rectangle 	L/D | C_D | L/D | C_D 0.1 | 1.9 | 1.0 | 2.2 0.2 | 2.1 | 1.2 | 2.1 0.4 | 2.35 | 1.5 | 1.8 0.5 | 2.5 | 2.0 | 1.6 0.65 | 2.9 | 2.5 | 1.4 0.8 | 2.3 | 3.0 | 1.3 6.0 | 0.89 $Re \geq 10^4$

Geometry	Drag Coefficient, C_D, and Remarks
Two Cylinders Side by Side 	E/D | C_D | C_L 0 | 1.6 | 0.8 0.25 | 1.0 | 0.6 0.5 | 0.9 | 0.4 1.0 | 1.1 | 0.2 1.5 | 1.3 | 0.1 2.0 | 1.2 | 0.05 4.0 | 1.2 | 0.0 6.0 | 1.2 | 0.0 C_D, C_L for each cylinder. $10^4 < Re < 10^5$. Lift force is repulsive.
Inclined Square 	θ(Deg) | 0 5 10 15 20 25 30 35 40 45 C_D | 2.2 2.1 1.8 1.3 1.9 2.1 2.2 2.3 2.4 2.4 $Re \geq 10^4$
Rounded Nose Section 	L/D | C_D 0.5 | 1.16 1.0 | 0.90 2.0 | 0.70 4.0 | 0.68 6.0 | 0.64 $Re \geq 10^4$
Thin Flat Plate Inclined to Flow  $T < 0.1D$	$C_N \approx \begin{cases} 2\pi \tan\theta, \theta < 8° \\ \dfrac{1}{0.222 + 0.283/\sin\theta}, \quad 90° \geq \theta > 12° \end{cases}$ $Re \geq 10^4$ $C_L = C_N \cos\theta$ $C_D = C_N \sin\theta$ There is a discontinuity in the range $8° < \theta < 12°$ with $C_N \approx 0.8$ as flow separates from upper surface. See Table 14.2 for $\theta = 0°$.
Thin Plate Extending from a Wall 	$C_D = 1.4$ $Re \geq 10^4$
Ellipse 	D/L | C_D 0.125 | 0.22 0.25 | 0.3 0.50 | 0.6 1.0 | 1.0 2.0 | 1.6 $Re \geq 10^4$ Laminar flow only.