UNIVERSITI SAINS MALAYSIA

Course Examination During Long Vacation
Academic Session 2008/2009
Peperiksaan Kursus Semasa Cuti Panjang
Sidang Akademik 2008/2009

June 2009
Jun 2009

EMH 102/3 – *Fluid Mechanics*
Mekanik Bendalir

Duration : 3 hours
Masa : 3 jam

INSTRUCTIONS TO CANDIDATE:
ARAHAN KEPADA CALON :

Please check that this paper contains **SEVEN (7)** printed pages, **TWO (2)** pages appendix and **SIX (6)** questions before you begin the examination.
*Sila pastikan bahawa kertas soalan ini mengandungi **TUJUH (7)** mukasurat bercetak, **DUA (2)** mukasurat lampiran dan **ENAM (6)** soalan sebelum anda memulakan peperiksaan.*

Answer **FIVE (5)** questions.
*Jawab **LIMA (5)** soalan.*

Answer all questions in **English** OR **Bahasa Malaysia** OR a combination of both.
*Calon boleh menjawab semua soalan dalam **Bahasa Malaysia** ATAU **Bahasa Inggeris** ATAU kombinasi kedua-duanya.*

Each question must begin from a new page.
Setiap soalan mestilah dimulakan pada mukasurat yang baru.

Appendix/*Lampiran*:

1. Gambarajah Moody [1 page/*mukasurat*]

2. Pemalar Kehilangan pada Pelbagai Sambungan [1 page/*mukasurat]*

Q1. [a] Explain the capillary effect and how it is caused by?

Terangkan kesan rerambut dan apakah yang menyebabkan kesan ini terjadi?

(30 marks/*markah*)

[b] The viscosity of a fluid is to be measured by a viscometer constructed of two 75 cm long concentric cylinders Figure Q1[b]. The outer diameter of the inner cylinder is 15cm, and the gap between the two cylinders is 0.12 cm. The inner cylinder is rotated at 200 rpm, and the torque is measured to be 0.8 Nm. Determine the viscosity of the fluid.

Kelikatan suatu bendalir adalah diukur dengan sebuah meter kelikatan yang dibina dengan dua silinder berpasang 75 sm panjang Rajah S1[b]. Jejari luaran bagi silinder dalaman ialah 15 sm, dan celahan di antara dua silinder ialah 0.12 sm. Silinder dalaman berputar pada 200 rpm, dan tork diukur adalah 0.8 Nm. Tentukan kelikatan bendalir.

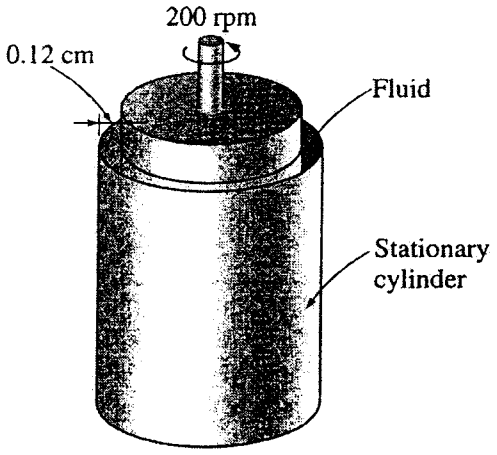


Figure Q1[b]
Rajah S1[b]

(70 marks/*markah*)

Q2. [a] Explain the cavitation phenomenon and how it is developed?

Terangkan kesan fenomena keronggaan dan bagaimanakah ia terbentuk?

(30 marks/*markah*)

[b] **The water in a tank is pressurized by air, and the pressure is measured by a multi fluid manometer as shown in Figure Q2[b]. The tank is located on a mountain where the atmospheric pressure is 85 kPa. Determine the air pressure if h_1= 0.1 m, h_2 = 0.2 m, and h_3 = 0.35 m. Take the density of oil, water and mercury to be 850 kg/m^3, 1000 kg/m^3 and 13,600 kg/m^3 respectively.**

Air di dalam sebuah tangki yang bertekanan udara, dan tekanan diukur dengan sebuah manometer bendalir pelbagai seperti yang ditunjukkan dalam Rajah S2[b]. Tangki ini diletakkan di atas sebuah gunung yang bertekanan atmosfera 85 kPa. Tentukan tekanan udara jika h_1= 0.1 m, h_2 = 0.2 m, dan h_3 = 0.35 m. Ambil ketumpatan minyak, air dan raksa masing-masing sebagai 850 kg/m^3, 1000 kg/m^3 and 13,600 kg/m^3.

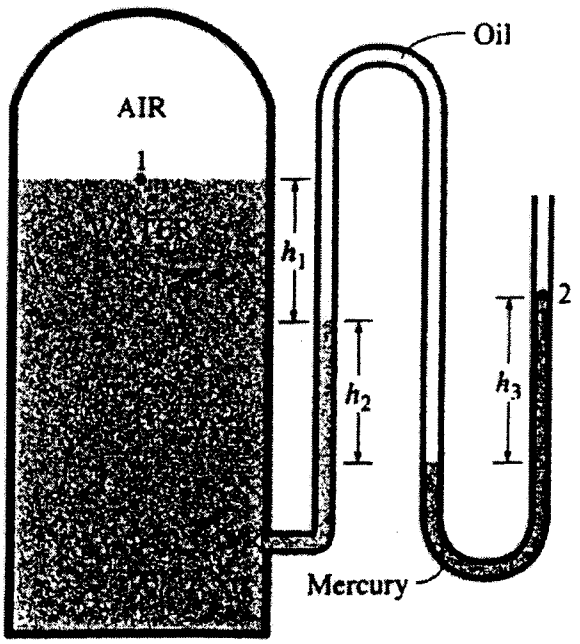


Figure Q2[b]
Rajah S2[b]

(70 marks/*markah*)

Q3. [a] **Estimate the depth d needed for the rectangular gate to automatically open if the weight W= 60 kN as shown in Figure Q3[a]. The gate is 4 m high and 2 m wide. Neglect the weight of the gate.**

Anggarkan kedalaman d yang diperlukan bagi pintu segiempat yang boleh dibuka secara automatik jika berat W = 60 kN seperti yang ditunjukkan dalam Rajah S3[a]. Pintu mempunyai 4 m tinggi dan 2 m lebar. Abaikan berat bagi pintu.

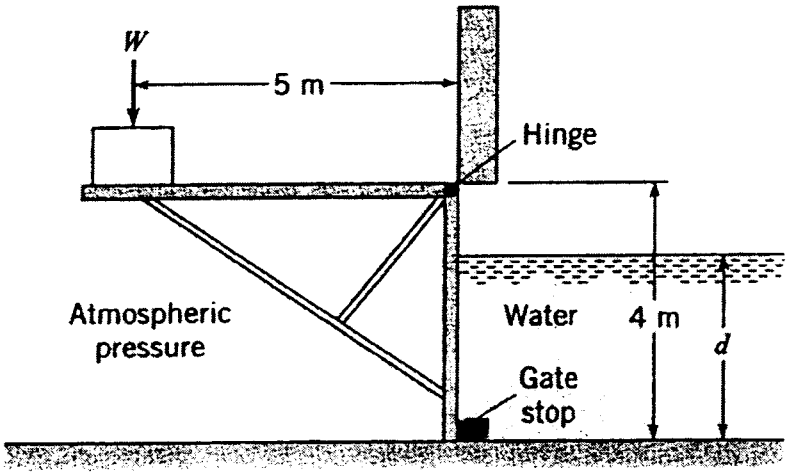


Figure Q3[a]
Rajah S3[a]

(50 marks/*markah*)

[b] A mercury-kerosene manometer is connected to the pitot-static tube as shown in Figure Q3[b]. The deflection on the manometer is 7 cm, determine the kerosene velocity in the pipe. Take the specific gravity of the kerosene is 0.81.

Sebuah manometer raksa-kerosin bersambung dengan tiub pitot-statik seperti yang ditunjukkan dalam Rajah S3[b]. Pesongan manometer ialah 7 sm, tentukan halaju kerosin di dalam paip. Ambil graviti tentu bagi kerosin sebagai 0.81.

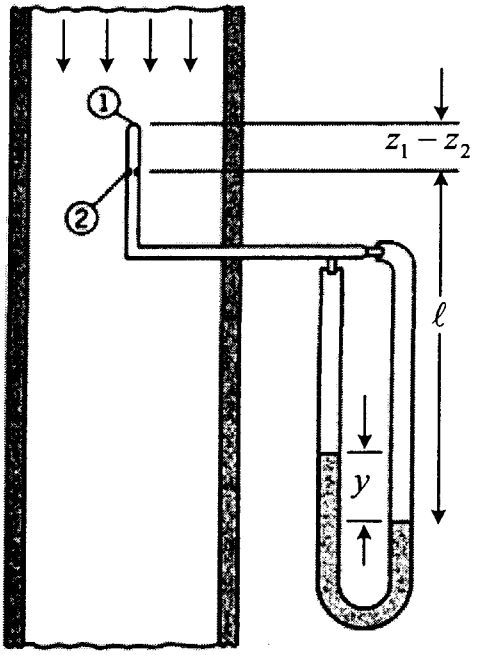


Figure Q3[b]
Rajah S3[b]

(50 marks/*markah*)

Q4. **[a]** **The water flows in a pipe with the velocity of 7.2 m/s. Express velocity in term of velocity head in meters of water. Calculate also this value in term of pressure kN/m^2.**

Air mengalir di dalam sebuah paip dengan halaju 7.2 m/s. Ungkapkan halaju ini dengan turus halaju dalam meter bagi air. Kirakan nilainya dalam tekanan kN/m^2.

(40 marks/*markah*)

[b] **An inviscid, incompressible fluid flows between wedge-shaped walls into small opening as shown in Figure Q4[b]. The potential velocity (in m^2/s), which approximately describes this flow is**

Bendalir tak likat, tak boleh mampat mengalir diantara dinding berbentuk baji yang mempunyai bukaan kecil seperti yang ditunjukkan dalam Rajah S4[b]. Halaju upaya (in m^2/s), yang boleh diramal aliran ini dengan

$$\phi = -2\ln r$$

Determine the volume flow rate (per unit length) into the opening.

Tentukan kadar aliran isipadu (per unit panjang) ke dalam bukaan.

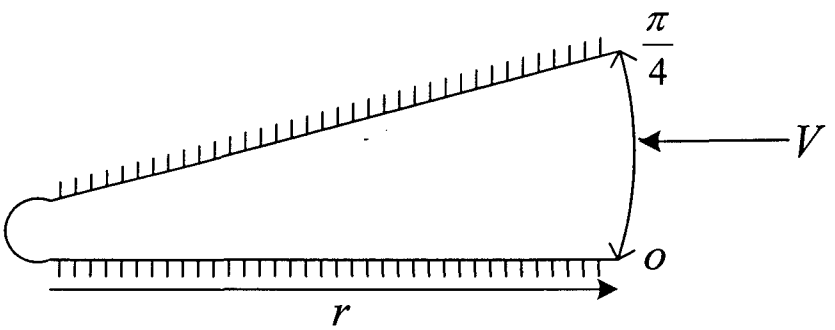


Figure Q4[b]
Rajah S4[b]

(60 marks/*markah*)

Q5. **[a]** **Consider the flow of air and water in pipes of the same diameter and at the same mean velocity. Which flow is more likely to be turbulent? Explain.**

Anggapkan aliran udara dan air di dalam paip yang sama diameter dan sama halaju purata. Aliran yang manakah berkemungkinan gelora? Terangkan.

(30 marks/*markah*)

[b] **Two tanks are connected with the piping system with the first pipe having a diameter of 150 mm and 6 m long, and the second pipe has a diameter of 225 mm with the length of 15 m Figure Q5[b]. The water surface in the first tank is 6 m above the second tank. Calculate the losses exist and determine the flow rate of flowing water. (Take the friction coefficient for both pipes as 0.01).**

Dua buah tangki disambungkan dengan sistem paip yang bergaris pusat 150 mm bagi 6 m panjang yang pertama dan bergaris pusat 225 mm bagi paip kedua yang panjangnya 15 m Rajah S5[b]. Permukaan air bagi tangki pertama berada 6 m di atas tangki kedua. Kirakan kehilangan yang wujud dan tentukan kadar aliran air yang mengalir. (Anggapkan pemalar geseran bagi kedua-dua paip adalah 0.01).

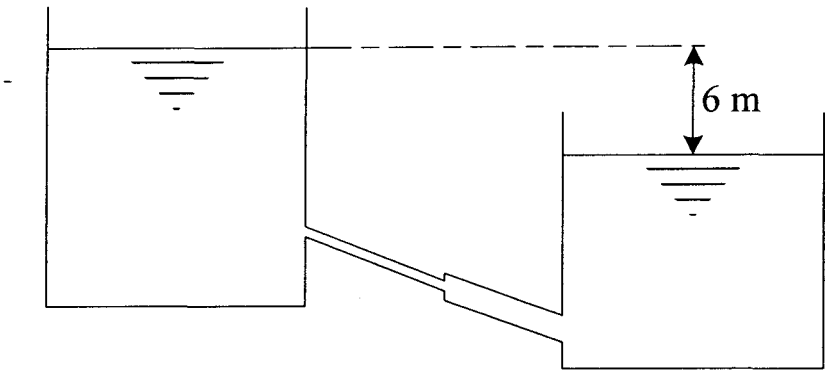


Figure Q5[b]
Rajah S5[b]

(70 marks/*markah*)

Q6. [a] **List and describe the three necessary conditions for complete similarity between a model and a prototype.**

Senarai dan terangkan tiga keadaan penting bagi keserupaan lengkap di antara sebuah model dan sebuah prototaip.

(40 marks/*markah*)

[b] **The discharge of a centrifugal pump is a function of the rotational speed of the pump, N, the diameter of impeller, D, the head across the pump, h_p, the viscosity of the fluid, μ, the density of the fluid, ρ and the acceleration due to gravity, g. The function relationship is**

$$Q = f(N, D, h_P, \mu, \rho, g)$$

Using the dimensional analysis, determine the dimensionless parameters. Express the answer in the form:

$$\frac{Q}{ND^3} = f(\pi_1, \pi_2, \pi_3)$$

Luahan bagi sebuah pam empar adalah adalah fungsi bagi halaju putaran pam, N, jejari bagi empar, D, turus merentasi pam, h_p, kelikatan bendalir, μ, ketumpatan bendalir, ρ dan cepatan disebabkan graviti, g. Hubungan fungsi adalah

$$Q = f(N, D, h_P, \mu, \rho, g)$$

Dengan menggunakan analisa dimensi, tentukan parameter-parameter tanpa dimensi. Ungkapkan jawaban dalam bentuk:

$$\frac{Q}{ND^3} = f(\pi_1, \pi_2, \pi_3)$$

(60 marks/*markah*)

-oooOOooo-

Gambarajah Moody

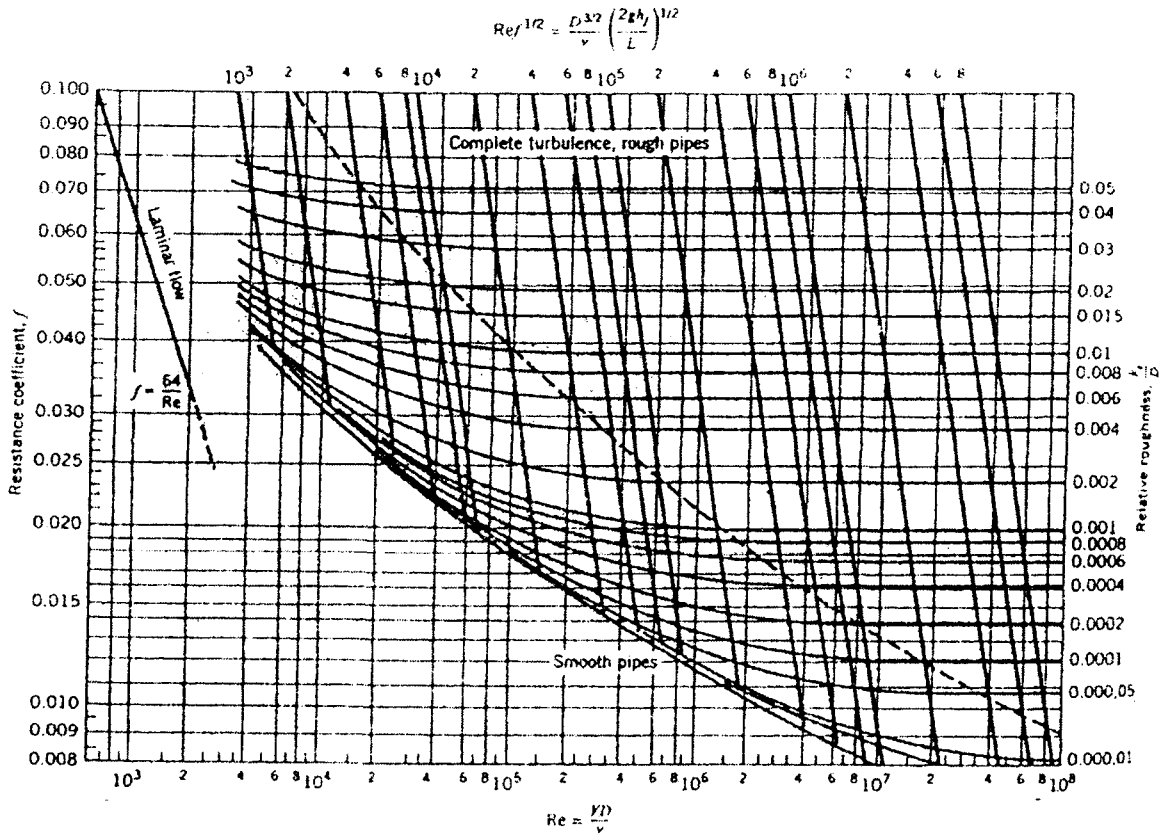


FIGURE 10.8

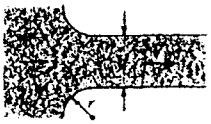
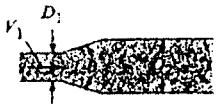
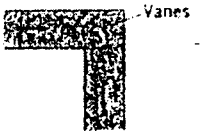
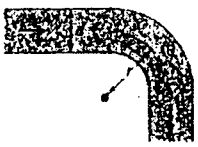
Resistance coefficient f versus Re. Reprinted with minor variations. [After Moody (31). Reprinted with permission from the A.S.M.E.]

TABLE 10.1 EQUIVALENT SAND-GRAIN ROUGHNESS, k_s, FOR VARIOUS PIPE MATERIALS

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

LAMPIRAN B

Pemalar Kehilangan pada Pelbagai Sambungan

Description	Sketch	Additional Data	K	Source
Pipe entrance $h_L = K_c V^2/2g$		r/d 0.0 0.1 >0.2	K_c 0.50 0.12 0.03	(2)*
Contraction $h_L = K_C V_2^2/2g$		D_2/D_1 0.0 0.20 0.40 0.60 0.80 0.90	K_C $\theta = 60°$ 0.08 0.08 0.07 0.06 0.06 0.06	K_C $\theta = 180°$ 0.50 0.49 0.42 0.27 0.20 0.10	(2)
Expansion $h_L = K_E V_1^2/2g$		D_1/D_2 0.0 0.20 0.40 0.60 0.80	K_E $\theta = 20°$ 0.30 0.25 0.15 0.10	K_E $\theta = 180°$ 1.00 0.87 0.70 0.41 0.15	(2)
90° miter bend		Without vanes	$K_b = 1.1$		(39)
		With vanes	$K_b = 0.2$		(39)
90° smooth bend		r/d 1 2 4 6 8 10	 $K_b = 0.35$ 0.19 0.16 0.21 0.28 0.32		(5) and (15)
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	$K_b = 0.4$			

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