Second Semester Examination
Academic Session 2017/2018

May/June 2018

EMH 102 – Fluids Mechanics
[Mekanik Bendalir]

Duration : 3 hours
[Masa : 3 jam]

Please check that this paper contains **NINE** **[9]** printed pages including appendix before you begin the examination.

*[Sila pastikan bahawa kertas soalan ini mengandungi **SEMBILAN** **[9]** mukasurat bercetak beserta lampiran sebelum anda memulakan peperiksaan.]*

INSTRUCTIONS : Answer **ALL FIVE [5]** questions.
*[**ARAHAN** : Jawab **SEMUA LIMA [5]** soalan.]*

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.]

Thermodynamic Booklet is provided.
Buku Termodinamik adalah dibekalkan.

1. [a] Discuss the following concepts (using equations where relevant) and make a reference to one real-world situation where they have relevance.

Bincangkan konsep berikut (menggunakan persamaan yang bersesuaian) dan buat rujukan pada satu situasi dunia-benar yang bersesuaian.

(i) Surface tension.
Ketegangan permukaan.

(ii) Cavitation and vapour pressure.
Keronggaan dan tekanan wap.

(iii) Capillarity.
Rerambut.

(30 marks/*markah***)**

[b] Differentiate the Newtonian and Non-Newtonian fluid and provide two examples for each fluid.

Bezakan bendalir Newton dan Bukan Newton dan bekalkan dua contoh bagi setiap bendalir.

(30 marks/*markah***)**

[c] A liquid is poured into a graduated cylinder is found to weigh 6N when occupying a volume of 500mL. Calculate the specific weight, mass density and specific gravity of the liquid.

Suatu cecair dituangkan ke dalam silinder berskala didapati beratnya 6N apabila mencapai isipadu 500mL. Kirakan berat tentu, ketumpatan jisim dan graviti tentu bagi minyak.

(40 marks/*markah***)**

2. [a] Consider the differential element of static fluid with constant density, derive the hydrostatic pressure P is varied linearly with depth, h from the fluid surface as:

Pertimbangkan unsur pembezaan bagi bendalir statik dengan ketumpatan malar, terbitkan tekanan hidrostatik P adalah berkadar lurus dengan kedalaman, h daripada permukaan cecair sebagai:

$$P = \gamma h$$

(30 marks/*markah***)**

[b] A spherical air bubble rises in water. At a depth of 9m its diameter is 4mm. Calculate its diameter just as it reaches the free surface where the pressure is 101.3kPa (Surface tension effects are negligible).

Satu buih udara sfera timbul di dalam air. Pada kedalaman 9m garis pusat buih adalah 4mm. Kirakan garis pusat buih apabila ianya timbul sampai di permukaan bebas yang mana tekanan adalah 101.3kPa (kesan ketegangan permukaan adalah diabaikan)

(30 marks/*markah***)**

[c] A small metal pan of length 100cm, width 20cm and depth 4cm is floating in water. When a vertical load of 1.5N/m is applied as shown in Figure 2[c], the pan is assumes the given configuration as shown. Calculate:

Sebuah pan keluli kecil yang panjang 100cm, lebar 20cm dan kedalaman 4cm timbul di dalam air. Apabila beban tegak 1.5N/m digunakan seperti ditunjukkan dalam Rajah 2[c], pan tersebut dianggapkan berkonfigurasi seperti yang ditunjukkan. Kirakan:

(i) The weight of the pan
Berat pan

(ii) The magnitude of the righting moment developed by the change of position of the line of action of the buoyant force.
Magnitud momen kanan terhasil dengan perubahan posisi garis bertindak bagi daya ketimbulan.

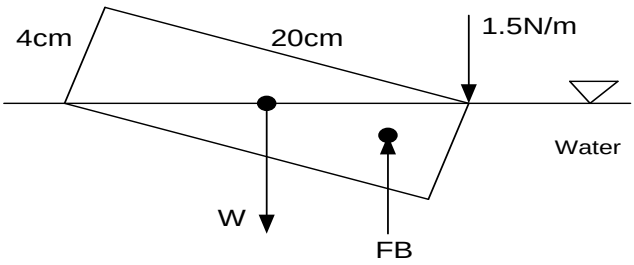

Figure 2[c]
Rajah 2[c]

(40marks/*markah***)**

3. [a] State all the heads exist in the flow field and explain their relationship.

Nyatakan kesemua turus wujud di dalam medan aliran dan terangkan perhubungan diantara mereka.

(30 marks/*markah***)**

[b] Oil with specific gravity of 0.85 issues from a 50mm diameter orifice under a pressure of 100kPa (gauge). The diameter of vena contracta is 39.5mm and the discharge is 18L/s. Calculate the coefficient of velocity.

Minyak dengan graviti tentu 0.85 mengalir daripada sebuah orifis bergaris pusat 50mm pada tekanan 100kPa (tolok). Garis pusat vena kontrakta adalah 39.5mm dan luahan adalah 18L/s. Kirakan pemalar halaju.

(40 marks/*markah***)**

[c] A 10cm diameter pipe has a water flow of 1200L/min at a pressure of 420kPa. Calculate:

Sebuah paip bergaris pusat 10cm mempunyai aliran air 1200L/min pada tekanan 420kPa. Kirakan:

(i) The pressure head of water in meter.
Turus tekanan air dalam meter.

(ii) The velocity head.
Turus halaju.

(iii) The total head with reference to a datum plane 7m below the pipe.
Jumlah turus dengan rujukan satah datum 7m dibawah paip.

(30 marks/*markah***)**

4. [a] Simplify head loss Eq. 4.1 to Eq. 4.2 for flow in pipe.

Ringkaskan turus kehilangan Eq. 4.1 kepada Eq. 4.2 untuk kes aliran dalam paip.

$$h_f = \frac{32\mu Vl}{\rho g D^2} \qquad \text{Eq. 4.1}$$

$$h_f = \frac{64}{\mathrm{Re}} \frac{l}{D} \frac{V^2}{2g} \qquad \text{Eq. 4.2}$$

(10 marks/*markah***)**

[b] Oil from oil tank is pumped to heat exchanger, then it returns to the tank, as shown in Figure 4[b]. The mass flow rate of oil = 1.257kg/s, the oil velocity = 0.2m/s, the oil density = 800 kg/m^3 and the oil dynamic viscosity = 3.2x10^{-3}N.s/m^2

Minyak dari tanki minyak dipam ke penukar haba, kemudian ia kembali ke tanki, seperti ditunjukkan pada Rajah 4[b]. Kadar aliran jisim minyak = 1.257kg/s, halaju minyak = 0.2m/s, ketumpatan minyak = 800 kg/m^{3}dan kelikatan dinamik minyak = 3.2x10^{-3}N.s/m^2

(i) Calculate diameter of the pipe.
Kirakan diameter paip.

(ii) Name the type of oil flow inside pipe. Give <u>ONE</u> reason for your answer.
*Namakan jenis aliran minyak dalam paip. Berikan **<u>SATU</u** sebab untuk jawapan anda.*

(iii) With the aid of Moody diagram, recommend the material type of pipe if friction coefficient (f)= 0.04.
Dengan bantuan gambarajah Moody, cadangkan jenis bahan paip sekiranya pekali geseran (f)= 0.04.

(iv) Calculate required power of the oil pump to overcome losses in pipe. Take coefficient of minor losses (K_L) for elbow = 0.9 and K_L heat exchanger = 20.

Kirakan kuasa yang diperlukan oleh pam minyak untuk mengatasi kehilangan dalam paip. Ambil pelaki kehilangan minor (K_L) untuk sesiku = 0.9 dan K_L penukar haba = 20.

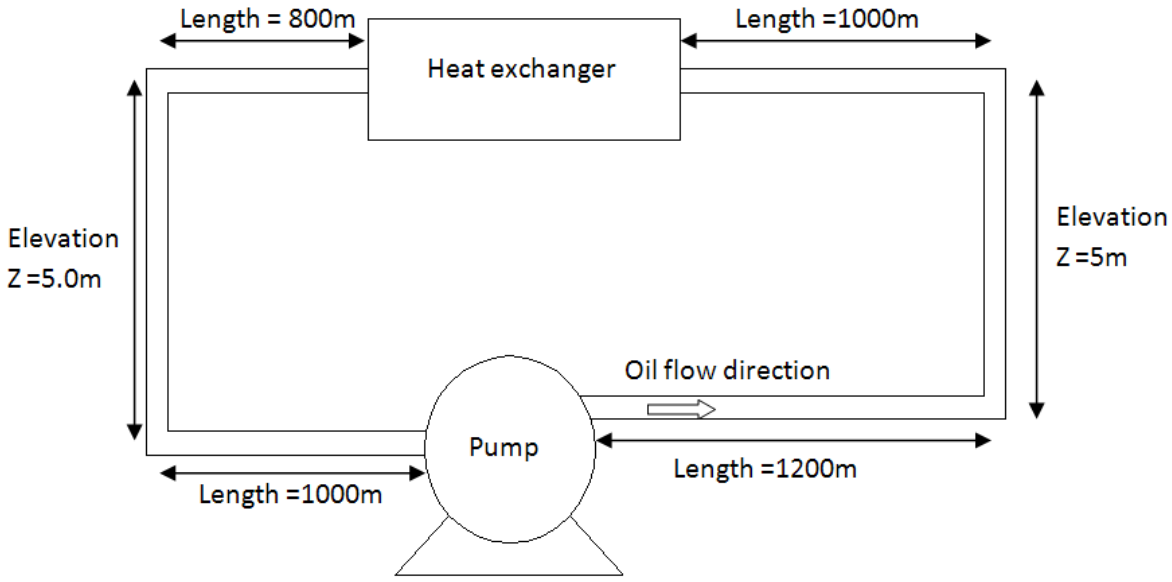

Figure 4[b]
Rajah 4[b]

(65 marks/*markah***)**

[c] With the aid of Figure 4[c], derive 2D continuity equation for incompressible flow.

Dengan bantuan Rajah 4[c], terbitkan persamaan keselanjaran untuk aliran tak mampat.

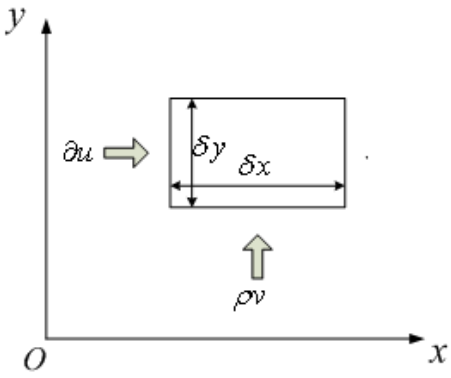

Figure 4[c]
Rajah 4[c]

(25 marks/*markah***)**

5. [a] A model of motorcycle is built to a scale of 1/3 and it is to be tested in a wind tunnel. Calculate the required velocity of wind tunnel if the prototype is cycling at 60km/h in the air with ambient temperature of 5°C. The temperature of wind tunnel = 5°C. GIVE ANSWER IN UNIT METER/SECOND.

Satu model motorsikal dibina pada skala 1/3 dan akan diuji dalam terowong angin. Kirakan halaju angin yang diperlukan sekiranya prototaip motorsikal bergerak pada 60km/h dalam udara dengan suhu persekitaran 5°C. Suhu terowong angin =5°C. *SILA JAWAB DALAM UNIT METER/SAAT.*

(20 marks/*markah***)**

[b] Velocity distribution between two flat surfaces with the distance t=4m as:

Taburan halaju antara dua permukaan rata dengan jarak t=4m sebagai:

$$u = 10\left(\frac{t^2}{16} - 2y^2\right)$$

Where u is the velocity in m/s at distance y from the central axis for both plates. Derive the expression of stream function.

Dimana u adalah taburan halaju pada jarak y dari paksi pusat untuk kedua-dua plat. Terbitkan ringkasan fungsi aliran.

(20 marks/*markah***)**

[c] **Given an equation of $\delta = f(x, V, \rho, \mu)$, where δ = boundary layer thickness (m), x= distance between leading edge to local point (m), V= free stream velocity (m/s), ρ= density (kg/m^3), and μ = dynamic viscosity (kg/m.s). By using Buckingham π theorem analysis, calculate an expression to show how δ depends on these variables. Take j=3.**

Diberi satu persamaan δ = f (x, V, ρ, μ), dimana δ= ketebalan lapisan sempadan (m), x=jarak antara bucu depan hingga titik tempatan (m), V= halaju aliran bebas (m/s), ρ = ketumpatan bendalir (kg/m^3) dan μ = kelikatan dinamik (kg/m.s). Dengan menggunakan teoram Buckingham π, kirakan ungkapan/rumusan untuk menunjukkan δ bergantung kepada pembolehubah-pembolehubah ini. Ambil j=3.

(60 marks/*markah***)**

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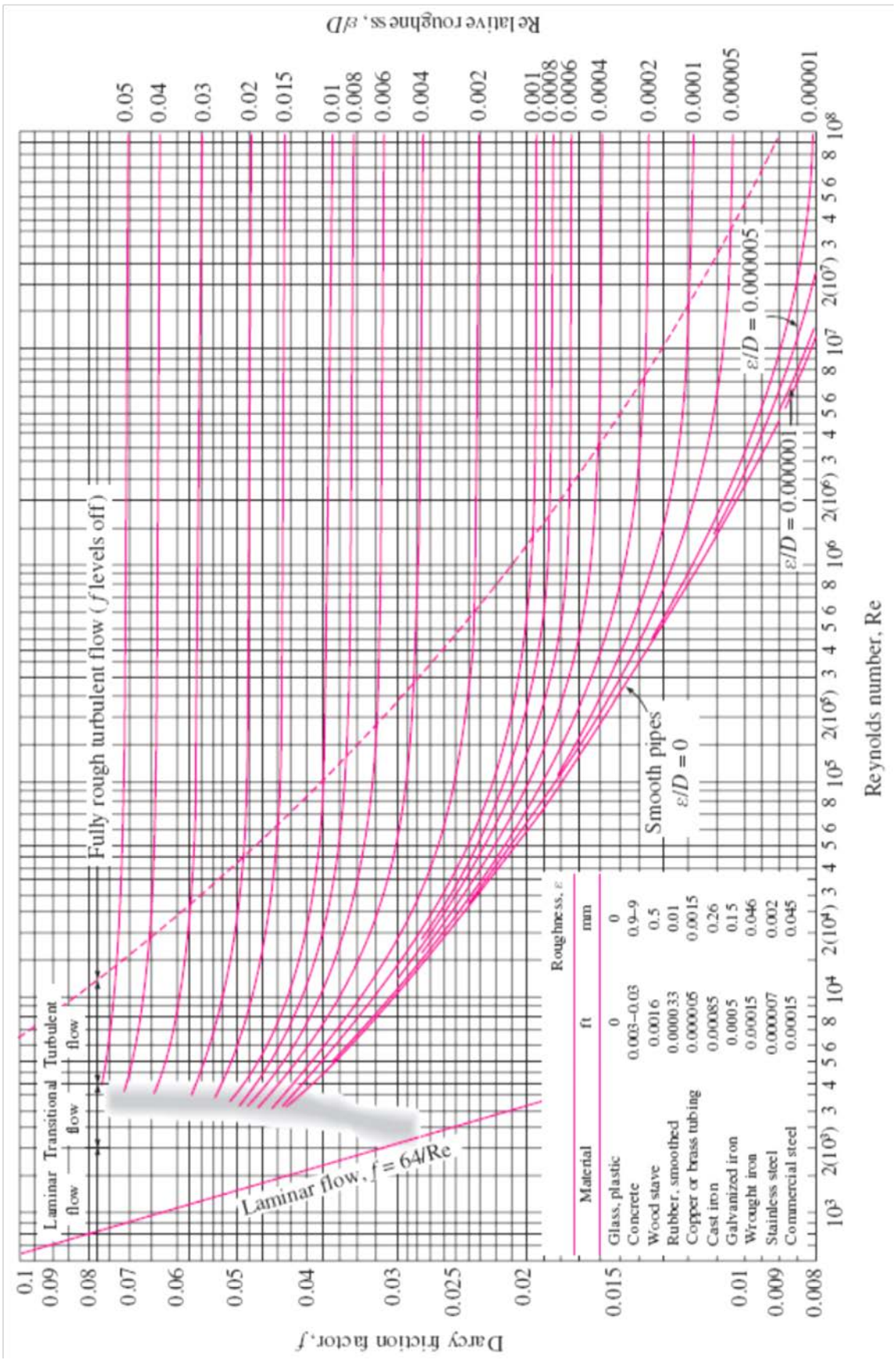
APPENDIX 1
LAMPIRAN 1


Relative roughness, ε/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
0.00001
Darcy friction factor, 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
Laminar flow
Transitional flow
Turbulent flow
Fully rough turbulent flow (f levels off)
Laminar flow, f = 64/Re
Smooth pipes
ε/D = 0
ε/D = 0.000001
ε/D = 0.000005
Reynolds number, Re
10³ 2(10³) 3 4 5 6 8 10⁴ 2(10⁴) 3 4 5 6 8 10⁵ 2(10⁵) 3 4 5 6 8 10⁶ 2(10⁶) 3 4 5 6 8 10⁷ 2(10⁷) 3 4 5 6 8 10⁸
Roughness, ε
Material | ft | mm
Glass, plastic | 0 | 0
Concrete | 0.003–0.03 | 0.9–9
Wood stave | 0.0016 | 0.5
Rubber, smoothed | 0.000033 | 0.01
Copper or brass tubing | 0.000005 | 0.0015
Cast iron | 0.00085 | 0.26
Galvanized iron | 0.0005 | 0.15
Wrought iron | 0.00015 | 0.046
Stainless steel | 0.000007 | 0.002
Commercial steel | 0.00015 | 0.045