Second Semester Examination
2023/2024 Academic Session

July / August 2024

EMH 102 – Fluid Mechanics
(Mekanik Bendalir)

Duration: 3 hours
(Masa: 3 Jam)

Please check that this examination paper consists of SIX (6) pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi ENAM (6) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions: Answer ALL **FIVE (5)** questions.

*[**Arahan**: Jawab **LIMA (5)** soalan]*

Booklet for Thermodynamics properties is provided.

Appendix I (Moody Chart) is provided.

...2/-

1. (a) A tube containing water is used by a researcher to measure pressure at point A, as shown in Figure 1 (a). Calculate the water height, h, and water pressure at point A. Take surface tension σ = 0.072 N/m, angle of contact θ=15°, tube diameter, D = 0.5 mm, and water density, ρ = 1000 kg/m^3.

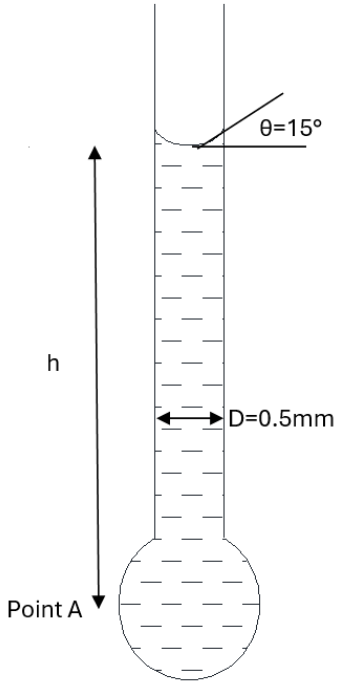

Figure 1 (a)

(50 marks)

(b) A cuboid shaped fuel tank containing fuel accelerates horizontally at 2 m/s^2. The tank is 4 m long and the fuel density is 820 kg/m^3. Calculate the minimum hydrostatic pressure on the tank's bottom surface. Take the initial fuel height of 2 m.

(50 marks)

...3/-

2. (a) Figure 2 (a) shows a manometer that has been used to measure the Gas A pressure containing two different manometer liquids; Liquid B and Liquid C. Calculate the pressure and density of Gas A. Assume Gas A as ideal gas with gas constant, R = 287 J/kg.K, and temperature 40°C. Take water density = 1000 kg/m^3.

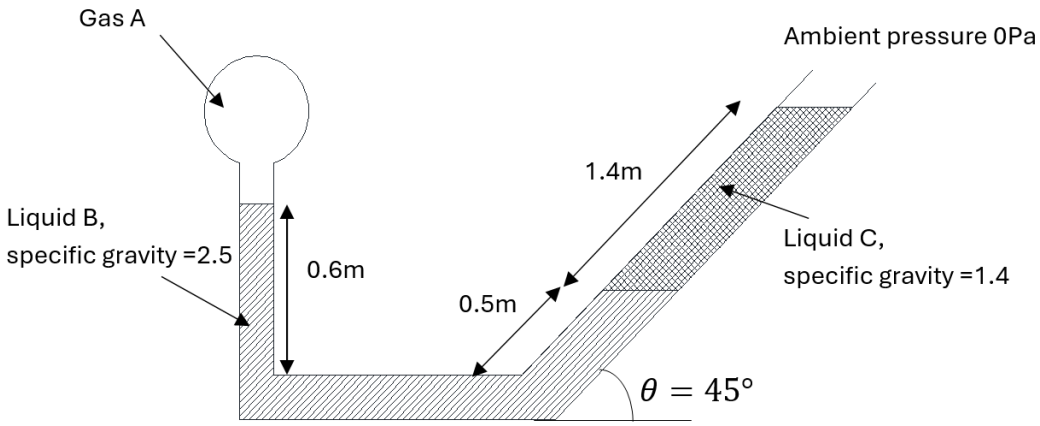

Figure 2 (a)

(50 marks)

(b) The air velocity in the duct of a heating system is to be measured by a pitot-static tube inserted into the duct parallel flow, as shown in Figure 2 (b). If the differential height between the water column connected to the two outlets of the tube is 2.4 cm. The air temperature and absolute pressure in the duct are 45^{o}C and 98 kPa, respectively. Calculate:

(i) The flow velocity
(ii) The pressure rise at the tip of the tube

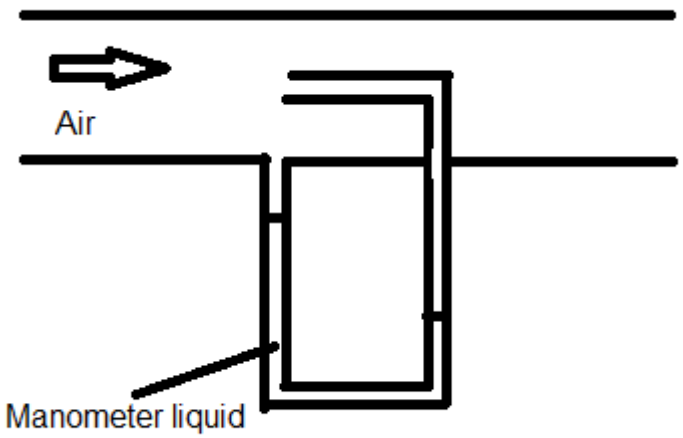

Figure 2 (b)

(50 marks)

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3. (a) The velocity in a two-dimensional flow field is given by the equation:

$$V = 2xt\tilde{\imath} - 2yt\tilde{\jmath}$$

The velocity is in m/s, x and y are in meter and t is in second.
Calculate:

(i) Local and convective components of acceleration in x and y directions
(ii) Magnitude of velocity and direction at point (1 m, 1 m)
(iii) Magnitude of acceleration at point (1 m, 1 m)

(60 marks)

(b) The stream function for an incompressible flow field is given by equation:

$$\varphi = 2x^2y - \frac{2}{3}y^3$$

(i) Show this stream function satisfies the continuity equation
(ii) Derive the velocity potential for this flow field

(40 marks)

4. Two reservoirs as depicted in Figure 4 are connected by pipes with three (3) different sizes.

(a) Considering flow continuity relationship, calculate the velocities in Pipe 2 and Pipe 3.

(30 marks)

(b) Considering only the major loss, calculate the total head loss of the pipes.

(70 marks)

The water properties at $20℃$ are density $\rho = 1000$ kg/m^{3}and dynamic viscosity $\mu = 0.001$ Pa.s. Moody chart is provided in Appendix I.

...5/-

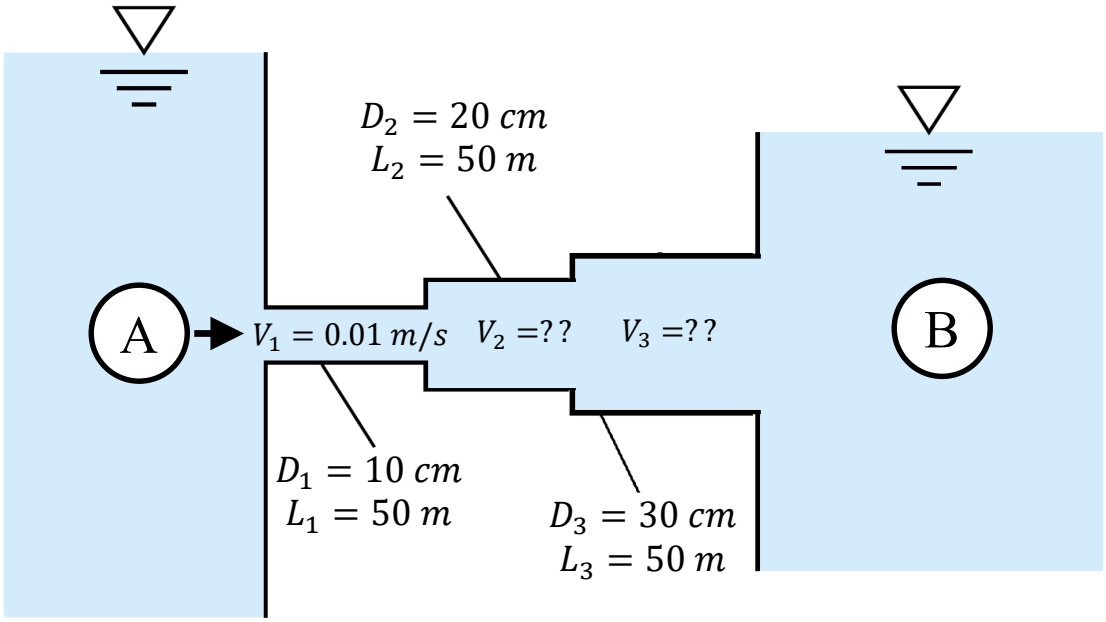

Figure 4

5. A continuous belt moving vertically through a bath of viscous liquid drags a layer of liquid of thickness h along with it. The volume flow rate of liquid Q is assumed to depend on μ, ρ, h and V where V is the belt velocity. The dynamic viscosity (in $kgm^{-1}s^{-1}$) and liquid density (in kgm^{-3}) are represented by μ and ρ, respectively. Apply dimensional analysis to derive the form of dependence of Q on other variables. Use ρ, V and h as repeating variables.

(100 marks)

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APPENDIX I

Moody chart