Second Semester Examination
2022/2023 Academic Session

July / August 2023

EMH 102 – Fluids Mechanic
(Mekanik Bendalir)

Duration: 3 hours
(Masa: 3 Jam)

Please check that this examination paper consists of FIVE (5) pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi LIMA (5) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

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

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

1. (a) An air flow at velocity of 70 m/s has the ambient temperature of 27°C. Calculate the Mach number of the flow. Justify either air flow in compressible or incompressible condition? Take adiabatic index of air γ =1.4.

(35 marks)

(b) The gate AB is used to stop water flow out from reservoir Figure 1 (b) shows the water reservoir with inclined steel gate AB. The steel gate AB is hooked at hinge C as shown in Figure 1 (b). Calculate minimum volume of steel gate AB to ensure no water flows out from the reservoir. Take water density = 1000 kg/m^3, the density of steel gate = 8000 kg/m^3. Use width of the gate AB, (b) = 1m.

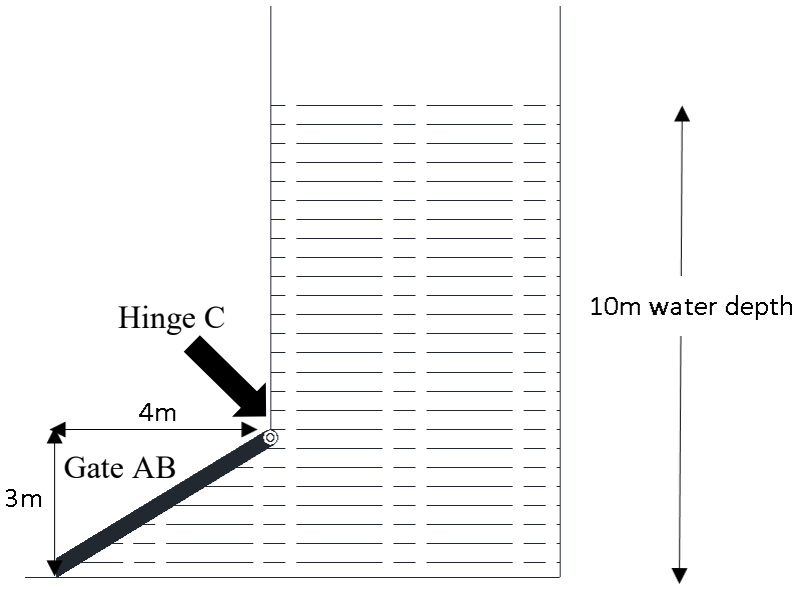

Figure 1 (b)

(65 marks)

2. (a) Figure 2 (a) shows a manometer that has been used to measure the gas pressure. The manometer contains two different manometer liquids; Liquid A and Liquid B. Gas pressure is 2 kPa, and the specific gravity of Liquid B is 2. Calculate the density of Liquid A.

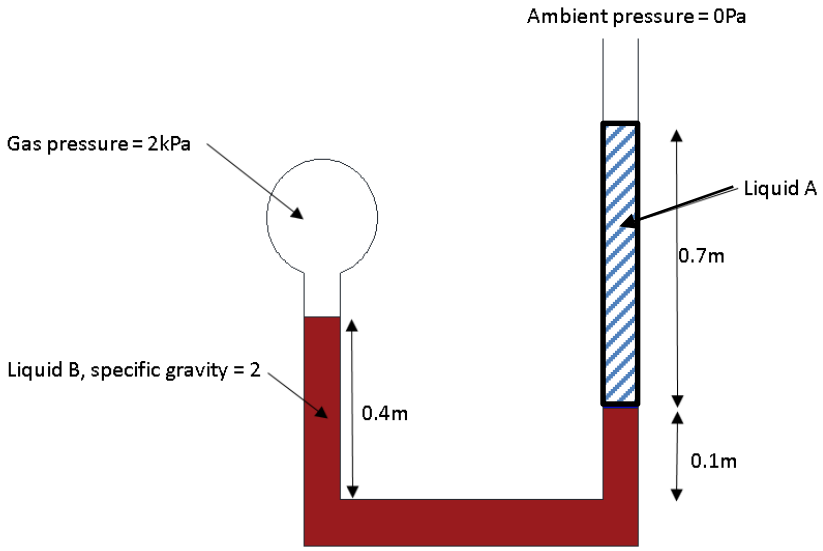

Figure 2 (a)

(50 marks)

(b) An inviscid fluid flows steadily through the contraction shown in Figure 2 (b). Derive an expression for fluid velocity at (2) in terms of inlet flow diameter D_1, outlet flow diameter D_2, density of inviscid fluid ρ, density of manometer liquid ρ_m, and manometer height h if the flow is assumed incompressible.

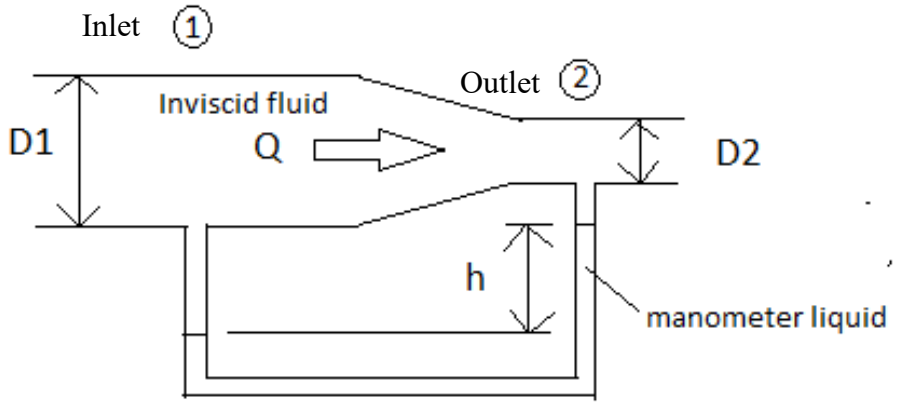

Figure 2 (b)

(50 marks)

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3. (a) Kerosene (specific gravity of 0.85) flows through the venturi meter as in Figure 3 (a) with flowrates between 0.005 m^3/s and 0.05 m^3/s. Calculate the range in pressure difference, P_1 - P_2, needed to measure these flowrates.

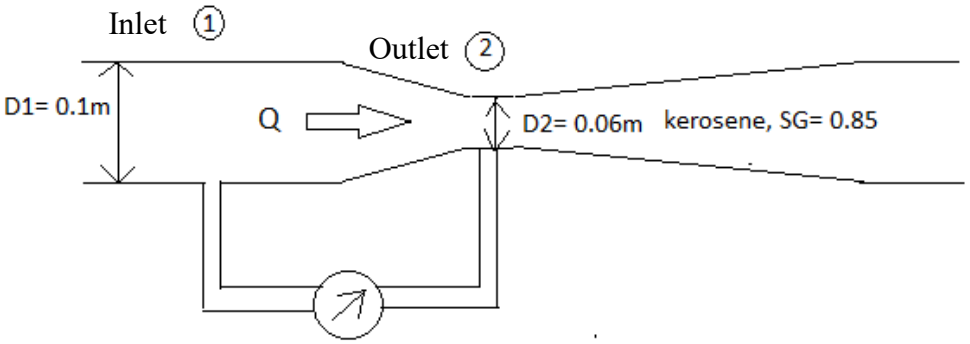

Figure 3 (a)

(40 marks)

(b) A friction less, incompressible unsteady flow field is given by

$$V = (x/t)\hat{\imath}$$

where x is in meter and t in seconds.

(i) Plot the velocity profile for 0 m ≤ x ≤ 10 m and t = 3 s.

(ii) Plot the velocity profile for x = 7 m and 2 s ≤ t ≤ 4s.

(iii) Calculate the local and convection acceleration.

(iv) Describe the velocity of a particle in this unsteady flow that remains constant throughout its motion.

(60 marks)

4. A pipe with 20 cm diameter and length of 100 m is connected to a water tank, as shown in Figure 4. Water level in the tank is 5 m height. Density of water is 1000 kg/m^3.

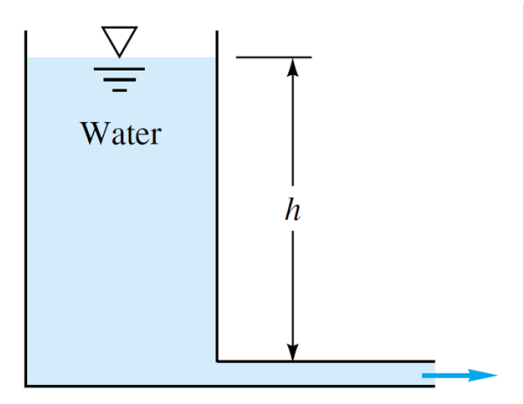

Figure 4

(a) Neglect the surface roughness of the pipe, calculate the water velocity at the pipe exit using the Bernoulli equation.

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

(60 marks)

(b) If the friction factor of the pipe is taken to be 0.05, calculate the water flow rate at the pipe exit.

(40 marks)

5. After a distance from the tube entrance, the velocity profile of fluid flow in a long straight tube become fully developed, where the velocity profiles no longer changes along the axial direction, as illustrated in Figure 5. As the shear stress (τ_w) in the tube is assumed to be a function of average velocity (V_{avg}), pipe diameter (D), fluid density (ρ), and fluid viscosity (μ). Using the Pi theorem, derive the appropriate dimensionless group.

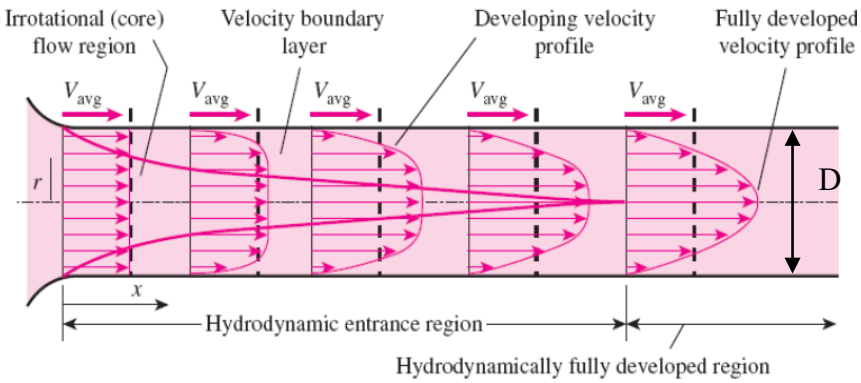

Figure 5

(100 marks)

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