Second Semester Examination
2020/2021 Academic Session

July/August 2021

EMH 102 – Fluid Mechanics

Duration: 2 hours

Please check that this examination paper consists of **FOUR (4)** pages .

Instructions : Answer ALL **FOUR (4)** questions.

Answer to each question must begin from a new page.

1. [a] Carbon monoxide (CO) with the temperature of 107°C, flows at velocity of 300m/s.

    (i) Calculate Mach number of carbon monoxide.

    (ii) Specify the type of flow, either compressible or incompressible flow. State your reason.

(40 marks)

[b] Figure Q1 (b) shows a manometer contain various liquids to measure pressure of gas A. Calculate the absolute pressure of gas A.

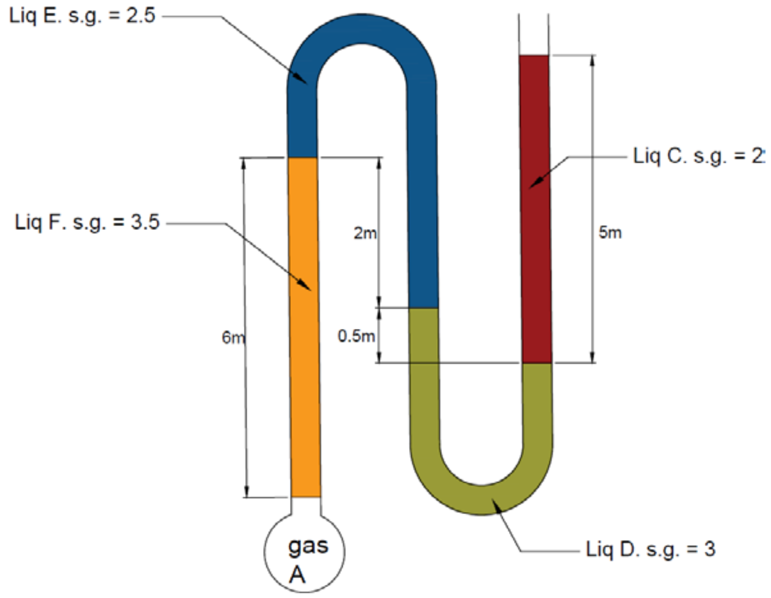

Figure Q1 (b)

(60 marks)

2. [a] The cross section of a tank is as shown in Figure Q2 (a). BC is a cylindrical surface. The tank contains water to a depth of 2m, calculate the magnitude and location of the horizontal and vertical force components on the wall ABC.

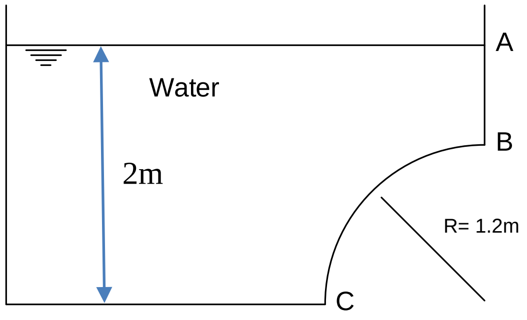

Figure Q2 (a)

(60 marks)

[b] A 30m/s jet of air flows past a ball as shown in Figure Q2 (b). When the ball is centered in the jet, the air greater on the side of the ball near the jet center (point 1) than it is on the other side of the ball (point 2). Calculate the pressure difference, $P_2 - P_1$, across the ball if V_1= 45m/s and V_2= 35m/s. The air temperature is 25^{o}C and neglect gravity and viscous effects.

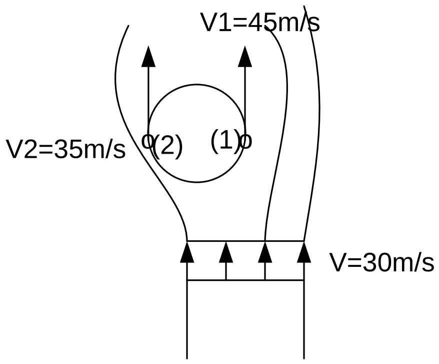

Figure Q2 (b)

(40 marks)

3. A rigid cylindrical tank is being filled with water by an inlet pipe as shown in the Figure above. Water at 20°C enters the tank at a velocity of 0.1ms−1. . Initially, the water height, h, inside the tank is 1/3 full.

   a) Using control volume analysis, write the expression for the change in the water height, dh/dt.
   b) Calculate dh/dt and duration to fill up the tank with water, given the following. Tank volume, $V = 38 \times 10^3\ litres,$ tank base diameter, D_2 = 1m, inlet pipe diameter, $D_1 = \frac{1}{10}\ D_2$. Neglect pipe friction losses.

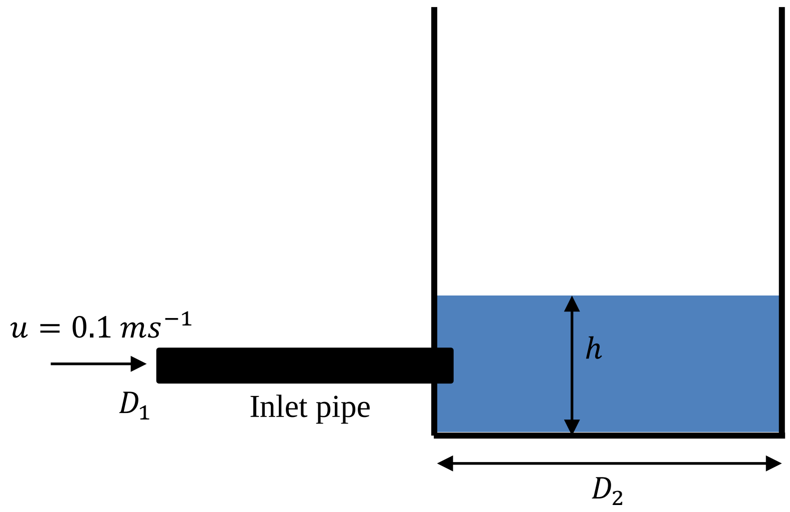

Figure Q3

(100 marks)

4. The terminal velocity of a sphere (maximum drop velocity) depends on sphere diameter (D), sphere density (ρ_s), fluid density (ρ_f), fluid viscosity (μ) and acceleration due to gravity (g). By using Buckingham π-Theorem, create a non-dimensional form for the terminal velocity. Show all the steps and calculations.

(100 marks)

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