Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	DAK 12403
PROGRAMME CODE	:	DAK
EXAMINATION DATE	:	JANUARY / FEBRUARY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **OPEN BOOK**

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) The property of fluid complies with the concept of continuum hypothesis. Explain the concept.

(2 marks)

(b) Discuss the assumptions and limitations for the concept of continuum hypothesis.

(4 marks)

(c) A blood capillary is a small blood vessel with the diameter of 4 μm which allows nutrients and waste substances to pass across it. The blood travels at the velocity of 300 μm s^{-1}. Given the density and the dynamic viscosity of blood are 1025 kg/m^3 and 3.5 x 10^{-3} Pa·s respectively.

(i) Calculate the kinematic viscosity of the blood.

(2 marks)

(ii) Calculate the Reynold number of the blood flow by the internal capillary diameter.

(2 marks)

(iii) Based on your answer in **Q1 (c) (ii)**, identify and explain the characteristics of the blood flow.

(3 marks)

(d) A liquid with the density of 765 kg/m^{-3} flows in a pipe with a contracted pipe fitting. It was observed that the velocity of the liquid increases from 2 ms^{-2} to 8 ms^{-2} and no changes in the volumetric flowrate were observed. If the diameter of the pipe at its initial region is 10 mm, calculate the followings:

(i) The area of the pipe at its initial region in m^2.

(3 marks)

(ii) The area of the pipe at the constriction region in μm^2.

(4 marks)

Q2 (a) There are several types of fluid properties which are classified as intensive and extensive groups. Define intensive and extensive properties and provide **two (2)** examples for each group.

(6 marks)

(b) A piece of unknown material has an intricate shape. It has a mass of 126 g. When the material is submerged in water, it displaces 422 ml of water. Calculate the followings:

(i) The density of the material in kg/m^3.

(4 marks)

(ii) The specific gravity of the piece.

(2 marks)

(iii) Based on your answer in **Q2 (b) (ii)**, determine whether the piece will float or sink in the water and explain your answer.

(2 marks)

(c) Knowing the heat energy of a fluid is important in understanding the heat transfer mechanism.

(i) Define the term heat energy and specific heat capacity.

(2 marks)

(ii) A piece of aluminum weighing 3 kg temperature is 300°C. The aluminum is submerged in water until it reaches 35 °C. Calculate the heat released (in kJ). Given the specific heat capacity of aluminum is 0.9 J/g °C.

(4 marks)

Q3 (a) Pressure is defined as the Normal force exerted by a fluid per unit area.

(i) Define the term absolute, atmospheric and vacuum pressure.

(3 marks)

(ii) A manometer is used to measure a pressure in a tank filled with liquid A with the *SG* of 0.85. If the P_{atm} is 96 kPa, determine the absolute pressure (in kPa) inside the tank. (Given h = 55 cm).

(4 marks)

(b) A rectangular shaped glass door with the dimensions of 1.5m (w) x 6m (h) is submerged in a water tank as in **Figure Q3 (b)**. Given the atmospheric pressure is 1 atm.

(i) State the Pascal's law.

(1 mark)

(ii) Calculate the B depth if the pressure acting at the A point is 4000 Pa.

(2 marks)

(iii) Calculate the resultant force acting on the glass door.

(5 marks)

(c) A 10 cm-radius of foam ball floats in glycerol where 70% of its volume is under the glycerol surface. Given that glycerol specific gravity is 1.13. Calculate its buoyant force (N).

(7 marks)

Q4 (a) Name **three (3)** major energies in the Bernoulli's equation.

(3 marks)

(b) A water hose is sprayed upwards from the ground floor to the top of the roof. The water velocity at the ground floor is 8 $m.s^{-1}$ and 0.5 $m.s^{-1}$ as it reached the top of the roof. Water density is as 1000 kg/m. Calculate the vertical distance of the sprayed water using Bernoulli's equation.

(5 marks)

(c) Derive the volumetric flowrate equation, Q based on **Figure Q4 (c)** and the Bernoulli's equation. Ignore the coefficient of discharge, *Cd* in the final equation.
[Hint: $z_1 = z_2,\ A_1 v_1 = A_1 v_1,\ Q = A \times v$]

(12 marks)

Q5 (a) Based on control volume and momentum balance theory:

(i) State **three (3)** types of control volume.

(3 marks)

(ii) Simplify the integral equation for conservation of mass, for a steady flow.

(3 marks)

(b) A girl is spraying a water horizontally to her friend just for fun. Explain what will happen to the linear momentum value if:

(i) The water has zero velocity as it hit her friend's body.

(2 marks)

(ii) The water makes a horizontal U-turn after it hit her friend's body.

(2 marks)

(c) Police is using a fire hose to disperse a crowd. The fire hose delivers 300 Liter/min of water at a velocity of 25 m/s. One man from the crowd picked up a garbage lid and use it as a shield to deflect the water. If water is stopped as it hit the shield, calculate the amount of force the man has to withstand.

(5 marks)

(d) A nozzle is attached to a fire hose using a flange. The valve is closed and the bolts holding the flange are loose. The nozzle diameter is 2.54 cm. Calculate the force that will make the flange tear apart when the water is pumped at 1 atm (101325 Pa).

(5 marks)

Q6 (a) Explain the effect of pipe length increment towards the inlet pipe pressure. (2 marks)

(b) Calculate the lowest budget (below RM 800) to purchase pipes and pumps from either supplier A or supplier B. The pipes must be able to carry water 30 meters away from a lake to a research office at the flowrate of 0.001 m^3/s (viscosity is 0.001 Pa.s). The pumps quantity must able to cover the pump power required. The specification from supplier A and B are outlined in the **Table Q6 (b)**. (18 marks)

– END OF QUESTIONS –

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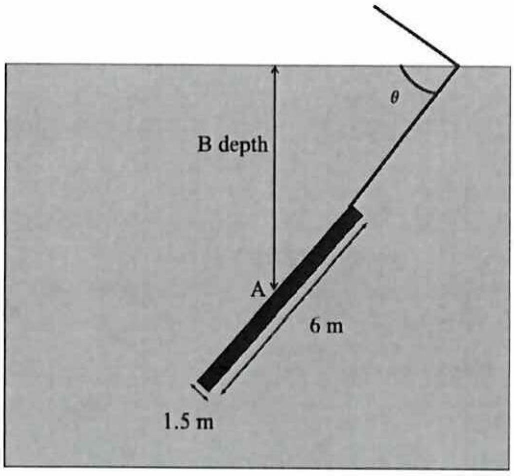

Figure Q3 (b)

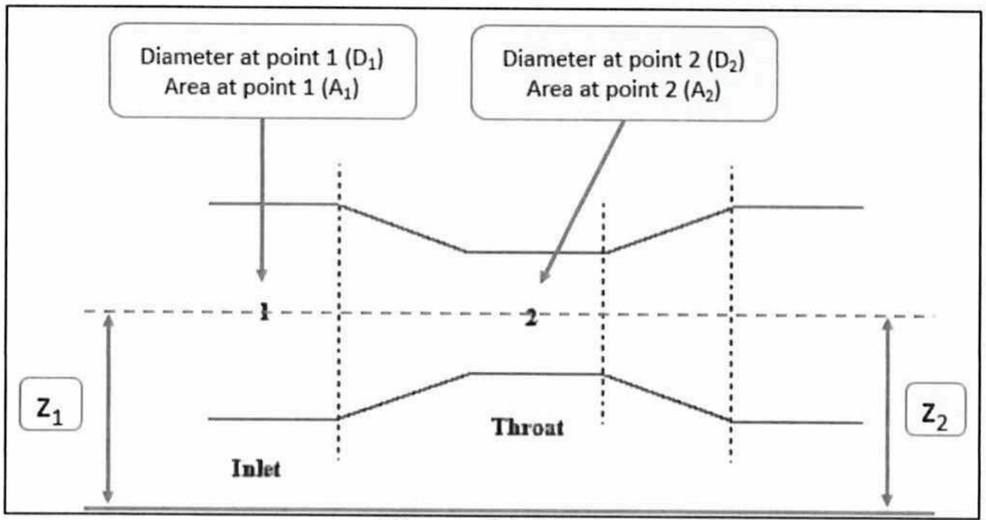

Figure Q4 (c)

Table Q6 (b)

Supplier A	Supplier B
Pipe A diameter = 2.54 cm Pipe A price = RM 10/meter	Pipe B diameter = 3.81 cm Pipe B price = RM 12/meter
 Pump A power = 25 Watt Pump A price = RM 200/unit	 Pump B power = 4 Watt Pump B price = RM 250/unit
Assume no fittings required	Assume no fittings required

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List of formula

$A = \pi D^2/4$

$v = \sqrt{\frac{\beta}{\rho}}$

$\dot{m} = Q \times \rho$

$\sigma = \frac{F}{2L} = N/m$

$SG = \rho_{fluid}/\rho_{water}$

$F_R = \frac{1}{2}\rho g d \times Bd$

$Y_R = 0.5d + \frac{Bd^3}{12 \times 0.5d \times (Bd)}$

$F_R = \left(\rho g s + \frac{1}{2}\rho g d\right) \times Bd$

$F_R = P_C A$

$Y_R = (s + 0.5d) + \frac{Bd^3}{12 \times (s + 0.5d) \times (Bd)}$

$F_B = \rho_f g V$

$W = \rho_{obj} g V$

$P_C = P_{atm} + \rho g h_C$

$P_C = P_{atm} + \rho g h_C \sin \theta A$

$\dot{m} = \rho \times A \times v$

$\rho_1 \times A_1 \times v_1 = \rho_2 \times A_2 \times v_2$

$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + z_2$

$\frac{dM}{dt} = \frac{\partial}{\partial t}\int_{CV} \rho . dV + \int_{CS} \rho \vec{v} . \vec{n} . dA$

$F_X = \rho Q(v_{x,in} - v_{x,out})$

$F_X = PA_{in} - PA_{out}$

$1 \text{ m}^3 = 1000$ Liter

$Q = A \times v$

$Q = ms\Delta T$

$Re = \frac{\rho D v}{\mu}$

$f = \frac{64}{Re}(laminar)$

$f = \frac{0.316}{Re^{(0.25)}}(turbulent)$

$h_L = f \times \frac{L}{D} \times \frac{v^2}{2g}$

$P_0 = \rho g h_L \times Q = \text{Watt}$

$\nu = \mu / \rho$

$V = \frac{4}{3}\pi r^3$