Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	: FLUID MECHANICS 1
COURSE CODE	: BDA20603
PROGRAMME CODE	: BDD
EXAMINATION DATE	: JULY/AUGUST 2023
DURATION	: 3 HOURS

INSTRUCTION

1. **PART A:** ANSWER **FOUR (4)** QUESTIONS **ONLY** OUT OF **FIVE (5)** QUESTIONS.
   PART B: ANSWER **ALL** QUESTIONS .
2. THIS FINAL EXAMINATION IS CONDUCTED VIA CLOSED BOOK.
3. STUDENTS ARE PROHIBITED TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

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

PART A: ANSWER FOUR (4) QUESTIONS ONLY OUT OF FIVE (5) QUESTIONS

Q1 (a) A compressed air tank has a volume of 0.024 m^3. The temperature is 20 °C and the atmospheric pressure is 101.3 kPa (abs). When the tank is filled with air at a gage pressure of 345 kPa, determine the density and the weight of the air in the tank. The gas constant of air is 287 J/kg.K.

(5 marks)

(b) The liquid is observed to rise 0.002 m above the free surface of a liquid when a 1-mm-diameter tube is inserted into the liquid in an open tank as shown in **Figure Q1 (b)**. The specific weight of the liquid is 1.2 x 10^4 N/m^3 and the value of the surface tension for this liquid is 31.5 x 10^{-3} N/m. Determine the contact angle between the liquid and the tube.

(7 marks)

(c) A thin plate moves between two parallel, horizontal, stationary flat surfaces at a constant velocity of 5 m/s as shown in **Figure Q1 (c)**. The two stationary surfaces are spaced 4 cm apart, and the medium between them is filled with oil whose viscosity is 0.9 $N.s/m^2$. The part of the plate immersed in oil at any given time is 2 m long and 0.5 m wide. If the plate moves through the mid-plane between the surfaces, determine

(i) The force required to maintain this motion.

(ii) The force required to maintain this motion if the plate was 1 cm from the bottom surface (h_2) and 3 cm from the top surface (h_1).

(8 marks)

Q2 (a) A multifluid manometer, as seen in **Figure Q2 (a)**, is used to measure the pressure of air-pressurized water in a tank. At the height of 1400 metres above sea level and an atmospheric pressure of 85.6 kPa, the tank is situated on a mountain. If h_1 = 0.1 m, h_2 = 0.2 m, and h_3 = 0.35 m, determine the absolute air pressure in the tank. Assume that water, oil, and mercury have relative densities of 1000 kg/m^3, 850 kg/m^3, and 13,600 kg/m^3.

(8 marks)

(b) A long solid cylinder of radius 0.6 m hinged at point A is used as an automatic gate as shown in **Figure Q2 (b)**. When the water level reaches 8 m, the gate opens by turning about the hinge at point A.

(i) Sketch the free-body diagram involved in the calculation.

(ii) Determine the hydrostatics force acting on the cylinder and its line of action.

(iii) Find the weight of the cylinder per 1 m length of the cylinder.

(12 marks)

Q3 (a) Explain the buoyancy force and the example of its application in your daily life. Provide a simple sketch to explain the buoyancy force.

(5 marks)

(b) Explain and compare the buoyancy of force acting on a 5 kg copper cube and a 5 kg copper ball.

(5 marks)

(c) An iceberg float in the ocean. Determine the percentage of the volume of the iceberg is underwater? Given the specific gravity of iceberg and ocean are 0.917 and 1.025, respectively.

(5 marks)

(d) An open water tank is moved on a truck that is travelling along a horizontal road at 89 km/hr. As the truck slows uniformly to a complete stop in 5 s, what will be the slope of the water surface during the period of constant deceleration?

(5 marks)

Q4 (a) A piezometer and a Pitot tube are tapped into a horizontal water pipe as shown in **Figure Q4 (a)** to measure static and stagnation pressure. Determine the velocity at the center of the pipe.

(8 marks)

(b) Air flows through a venturi meter whose diameter is 6.6 cm at the entrance part (location 1) and 4.6 cm at the throat (location 2). The gage pressure is 84 kPa at the entrance and 81 kPa at the throat.

(i) By neglecting the frictional effects, show that the flow rate can be expressed as

$$Q = A_2 \sqrt{\frac{2(P_1 - P_2)}{\rho(1 - A_2^2/A_1^2)}}$$

(ii) By taking the air density to be 1.2 kg/m^3, find the flow rate, Q.

(12 marks)

Q5 (a) A reducing elbow in a horizontal pipe as shown in **Figure Q5 (a)** is used to deflect water by an angle of 45° from the flow direction while accelerating it. The elbow discharges water into the atmosphere. The cross-sectional area of the elbow is 0.015 m^2 at the inlet and 0.0025 m^2 at the exit. The elevation difference between the centers of the exit and the inlet is 40 cm. The mass of the elbow and the water in the elbow is 50 kg. Determine the anchoring force needed to hold the elbow in place.

(10 marks)

(b) Water flow steadily at a rate of 0.16 m^3/s is deflected downward by an angled elbow as shown in **Figure Q5(b)**. Using the data in **Table Q5(b)**, determine the force acting on the flanges of the elbow. Assume that the weight of the elbow material, the weight of the water in the elbow and the frictional effects are neglected.

(10 marks)

PART B: ANSWER ALL QUESTION

Q6 (a) The drag coefficient is a dimensionless representation of the frictional effect, also known as drag force, experienced by an airplane wing as it moves through the air. The drag coefficient C_d is defined as

$$C_d = \frac{D_f}{\frac{1}{2}\rho V^2 A}$$

Verify that the drag coefficient C_d is dimensionless.

(5 marks)

(b) The efficiency of a pump, η is assumed to be a function of discharge flow rate, Q, pressure increase, Δp, pipe diameter, D, and fluid properties density, ρ and viscosity, μ. Find an expression for pump efficiency using dimensional analysis, where the SI units are tabulated as in **Table Q6 (b)**. Use Q, D and ρ as the repeating variables.

$$\eta = f(Q, \Delta P, D, \rho, \mu)$$

(15 marks)

-END OF QUESTIONS-

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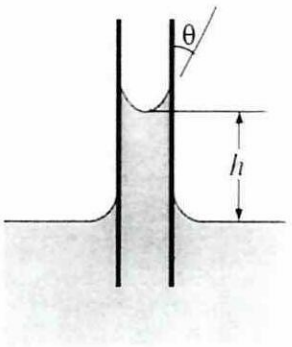

Figure Q1 (b)

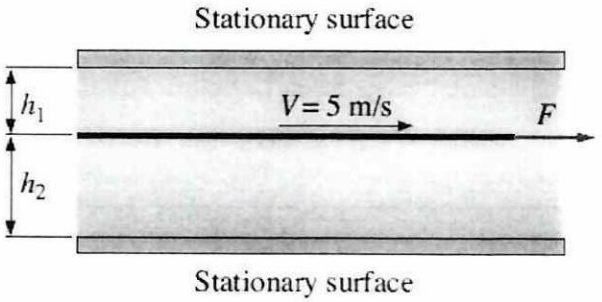

Figure Q1 (c)

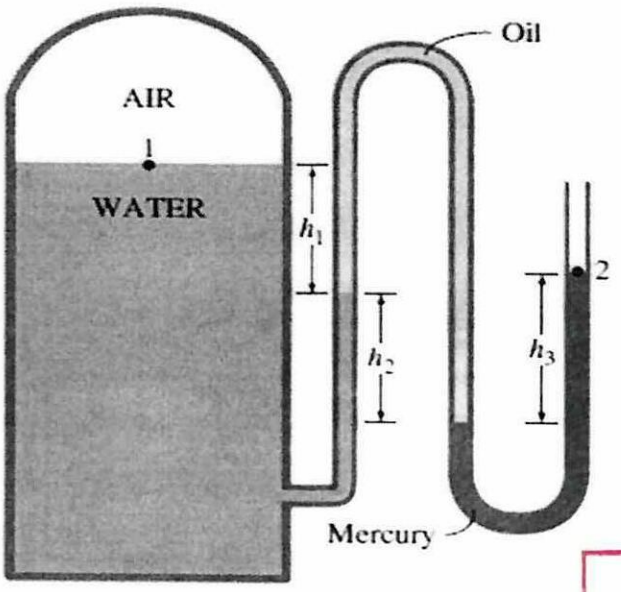

Figure Q2 (a)

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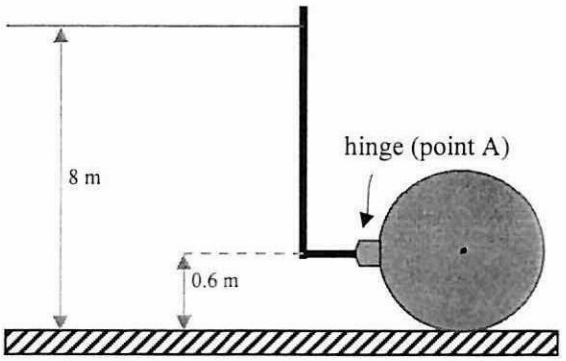

Figure Q2 (b)

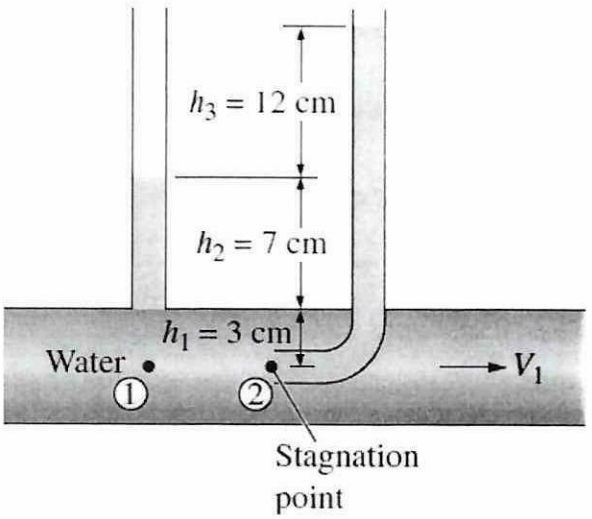

Figure Q4 (a)

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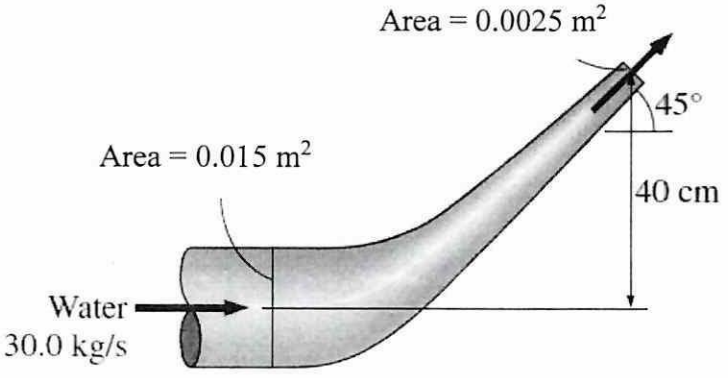

Figure Q5 (a)

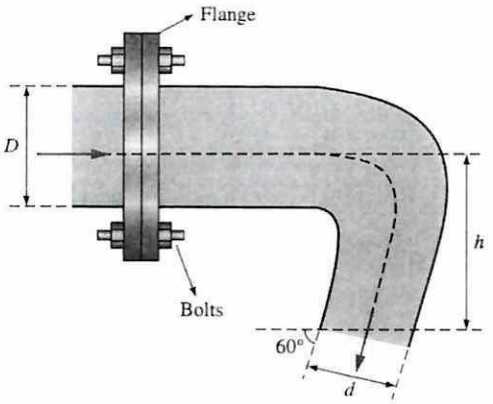

Figure Q5 (b)

Table Q5(b)

Paremeter	Value
D	30 cm
d	10 cm
h	50 cm
volume	0.03 m^3

Table Q6 (b)

No.	Quantity	Unit
1	Flow Rate	m^3/s
2	Pressure Increase	N/m^2
3	Pipe Diameter	m
4	Fluid Properties Density	kg/m^3
5	Viscosity	$N.s/m^2$