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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	BDJ 20203
PROGRAMME CODE	:	BDJ
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. 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

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Q1 (a) Based on your understanding on the terms of unsteady flow and transient flow, differentiate these classifications of fluid flow behaviour. Give an example for each type of fluid flow to support your answer.

(4 marks)

(b) The pressure in an automobile tire depends on the temperature of the air in the tire. When the air temperature is 25°C, the pressure gage reads 210 kPa. If the volume of the tire is 0.025 m^3

(i) Determine the pressure rise in the tire when the air temperature in the tire rises to 50°C.

(6 marks)

(ii) Estimate the amount of air that must be bled off to restore pressure to its original value at this temperature.

(3 marks)

Assume the atmospheric pressure to be 100 kPa.

(c) A pontoon shaped square having 6 m width, 12 m length and floating in 1.5 m depth water. As the density of water, ρ =1000 kgm^{-3}, determine:

(i) The weight of pontoon in an unloaded condition

(2 marks)

(ii) Its buoyancy depth if the pontoon is submerged in sea water. Given, density of sea water, ρ =1025 kgm^{-3}.

(2 marks)

(iii) The weight that can be borne if its maximum buoyancy is 2 m.

(2 marks)

(d) A piezometer and a pitot tube are tapped into a horizontal water pipe, as shown in **Figure Q1 (d)**, to measure static and stagnation pressures. For the indicated water column heights, determine the velocity at the center of the pipe.

(6 marks)

Q2 (a) State the **THREE (3)** limitations on the use of the Bernoulli equation

(3 marks)

(b) Air flows through a pipe at a rate of 200 L/s as shown in **Figure Q2 (b)**. The pipe consists of two sections of diameters 20 cm and 10 cm with a smooth reducing section that connects them. The pressure difference between the two pipe sections is measured by a water manometer. Neglecting frictional effects, determine the differential height of water between the two pipe sections. Take the air density to be 1.20 kg/m^3.

(7 marks)

(c) A very large tank contains air at 102 kPa at a location where the atmospheric air is at 100 kPa and 20°C is shown in **Figure Q2 (c)**. Now, a 2 cm diameter tap is opened.

(i) Determine the maximum flow rate of the air through the hole.

(6 marks)

(ii) Justify your response if air is discharged through a 2 m long, 4 cm diameter tube with a 2 cm diameter nozzle.

(2 marks)

(iii) Evaluate the problem the same way if the pressure in the storage tank were 300 kPa.

(2 marks)

(d) The water level in a tank is 15 m above the ground, **Figure Q2 (d).** A hose is connected to the bottom of the tank, and the nozzle at the end of the hose is pointed straight up. The tank cover is airtight, and the air pressure above the water surface is 3 atm gage. The system is at sea level. Determine the maximum height to which the water stream could rise.

(5 marks)

Q3 (a) State Newton's Second Law of Motion that relates to the conservation of momentum.

(2 marks)

(b) Based on the momentum principle, the total of the forces acting on an element of fluid is equal to the rate of change of momentum. Describe these forces that need to be taken into consideration.

(3 marks)

(c) A reducing elbow in a horizontal pipe is used to deflect water flow by an angle $\Theta = 45°$ from the flow direction while accelerating it as shown in **Figure Q3 (c).** The elbow discharges water into the atmosphere. The cross- sectional area of the elbow is 150 cm^2 at the inlet and 25 cm^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 it is 50 kg. Determine the anchoring force needed to hold the elbow in place. Take the momentum flux correction factor to be 1.03 at both the inlet and outlet.

(15 marks)

(d) Firefighters are holding a nozzle at the end of a hose while trying to extinguish a fireas shown in **Figure Q3 (d).** If the nozzle exit diameter is 8 cm and the water flow rate is 12 m^3/min, determine:

(i) The average water exits velocity.

(2 marks)

(ii) The horizontal resistance force required of the firefighters to hold the nozzle.

(3 marks)

Q4 (a) Define the use of Reynolds number.

(2 marks)

(b) Distinguish the difference between laminar and turbulent flow based on its definition, velocity and Reynolds number.

(3 marks)

(c) Water at 10 °C flows from a large reservoir to a smaller one through a 5 cm diameter cast iron piping system, as shown in **Figure Q4 (c)**. Determine the elevation z_1 for a flow rate of 6 L/s. Use the Moody Diagram provided to calculate the friction factor.

Given: Takes the density and dynamic viscosity of water at 10 °C are $\rho = 999.7$ kg/m^3, $\mu = 1.307\times10^{-3}$ kg/ms and $\varepsilon = 0.00026$ m.

(10 marks)

(d) There are two broad categories of turbomachinery, pumps and turbines.

(i) Distinguish between pump and turbine in term of it purpose and relate it with the fluid pressure

(4 marks)

(ii) A positive displacement pump moves a fluid by repeatedly enclosing a fixed volume and moving it mechanically through the system. The pumping action is cyclic and can be driven by pistons, screws, gears, rollers, diaphragms, or vanes. Sketch, **TWO (2)** examples of positive-displacement pumps.

(6 marks)

-END OF QUESTION –

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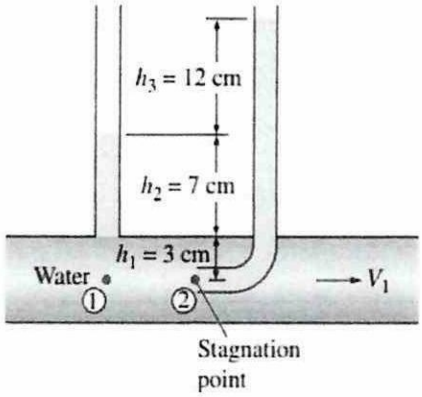

Figure Q1 (d)

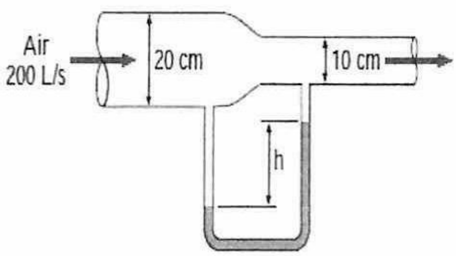

Figure Q2 (b)

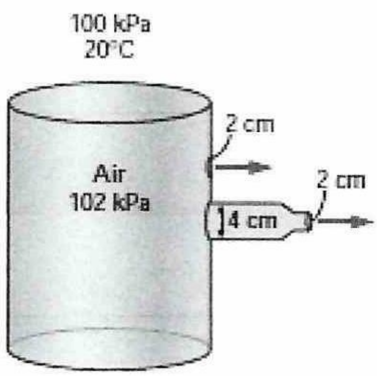

Figure Q2 (c)

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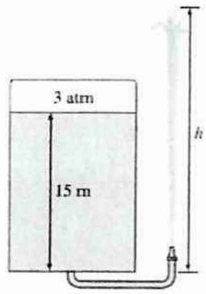

Figure Q2 (d).

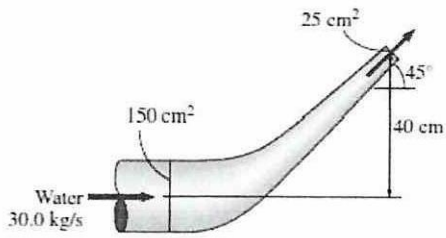

Figure Q3 (c)

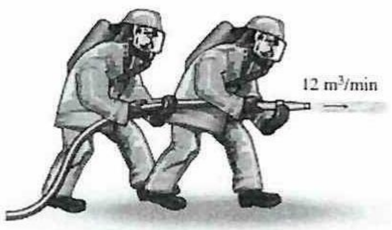

Figure Q3 (d).

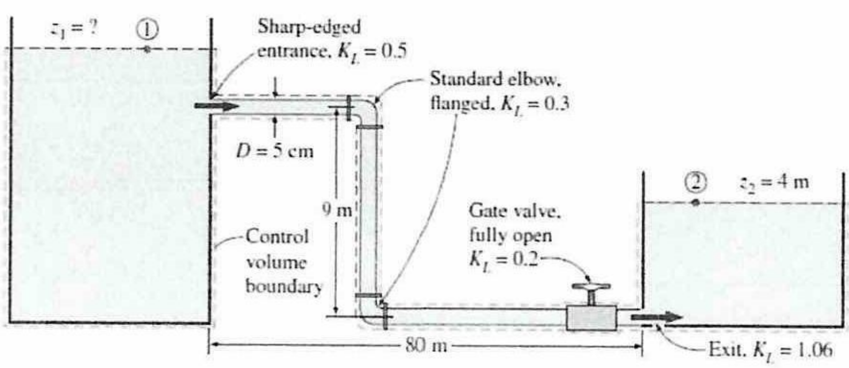

Figure Q4 (c).

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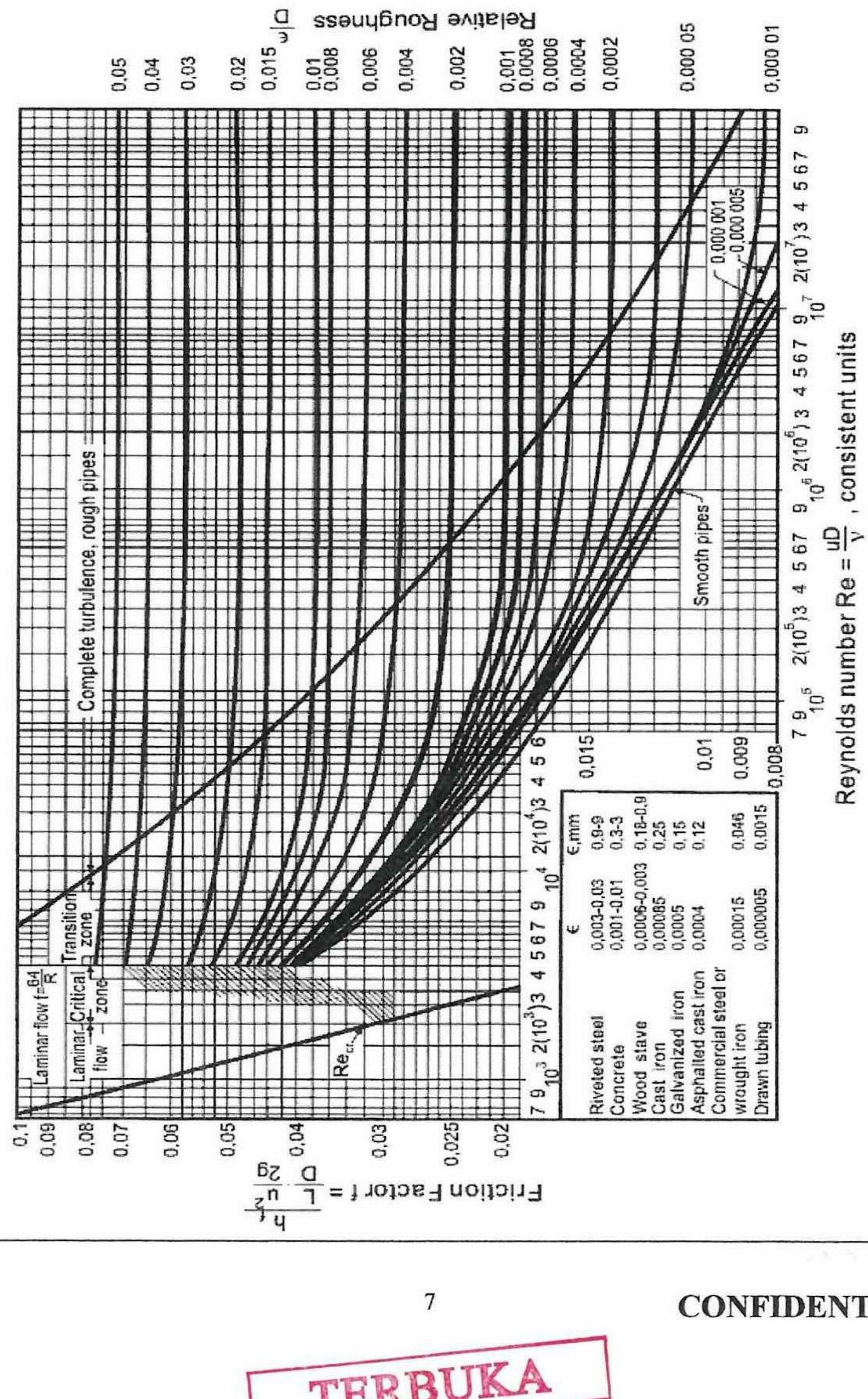
Moody Diagram



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1. $$\gamma = \rho g$$
2. $$SG = \frac{\gamma}{\gamma_{water}}$$
3. $$2\pi R\sigma cos\theta = \rho g\pi R^2 h$$
4. $$F = PA = \rho gh.A$$
5. $$y_R = \frac{I_X}{y_c A} + y_c$$
6. $$h_R = \frac{I_X sin^2\theta}{h_c A} + h_c$$
7. $$W = F_B = \rho gV$$
8. $$\dot{m} = \rho\, A\, v = \rho Q$$
9. $$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P}{\rho g} + \frac{V_2^2}{2g} + z_2$$
10. $$\sum F = \dot{m}\,(v_2 - v_1)$$
11. $$h_L = K_L\left[\frac{V^2}{2g}\right]$$
12. $$h_L = f\frac{L}{D}\left[\frac{V^2}{2g}\right]$$
13. $$\dot{W}_{water\ horsepower} = \dot{m}gH = \rho g\dot{V}H$$
14. $$PV = mRT$$