CONFIDENTIAL

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	FLUID MECHANICS 1
COURSE CODE	:	BDA 20603
PROGRAMME	:	BDD
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	**PART A:** ANSWER **THREE (3)** QUESTIONS **ONLY** OUT OF **FOUR (4)** QUESTIONS **PART B:** ANSWER **ALL** QUESTIONS

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

PART A: ANSWER THREE (3) QUESTIONS ONLY OUT OF FOUR (4) QUESTIONS

Q1 (a) Determine the specific weight of Fluid 3, shown in **Figure Q1 (a).**

(4 marks)

(b) Two identical square gates close two openings in a conduit connected to an open tank of water, as shown in **Figure Q1 (b).** Each of the gates weight 156.96 kN. It is desired that both gates open at the same time at a specific value of the water depth, *h*. Determine the water depth, *h*, and the horizontal force, *R*, acting on the vertical gate that is required to keep the gates closed until this depth is reached. Both gates are hinged at one end as shown. Friction in the hinges is negligible.

(16 marks)

Q2 A wooden cylinder has the dimension: diameter, $d = 10$ cm and height, $h_{cyl} = 40$ cm. The relative density of the wooden cylinder is 0.6. An aluminium disc with a diameter of 10 cm and height, $h_{al} = 5$ cm is rigidly attached to the bottom end of the wooden cylinder. The relative density of the aluminium is 2.7. The combination of wooden cylinder and aluminium disc are placed in the water with their axis are in a vertical position.

(i) Sketch a diagram to indicate all forces acting on the combined body as a floating body and all-important points.

(ii) Calculate the height of the combined body, which is below the water surface.

(iii) If the height of the aluminium is to be changed, determine its minimum value so that the combined body is fully submerged.

(20 marks)

Q3 (a) Define the discharge coefficient used in connection with flow through flow measurement devices and explain why this coefficient is necessary.

(3 marks)

(b) If p_1 and p_2 are the pressure at inlet and throat of a venturi meter while the area of the inlet and throat represented by A_1 and A_2 respectively, show that discharge of fluid through a venturi meter can is as follows;

$$Q = \frac{A_1}{\sqrt{m^2 - 1}} \sqrt{\frac{2(p_1 - p_2)}{\rho} + (z_1 - z_2)}$$

where m is an area ratio A_1/A_2.

(7 marks)

(c) Air at 120 kPa and 40°C flow downward through a 0.08 m inlet diameter of inclined venturi meter at a rate of 50 L/s, as in **Figure Q3 (c)**. The diameter of the throat is 0.05 m. The pressure change across the venturi meter is measured by a water manometer. The elevation difference between the inlet and throat of the venturi, h = 0.5 m. Determine the differential height, R between the fluid levels of the two arms of the manometer.

(10 marks)

Q4 (a) A vertical jet of water leaves a nozzle of diameter 2 cm, at a speed of 8.45 m/s, and suspends a plate of a mass of 1.5 kg as indicated in **Figure Q4 (a)**. Determine the vertical distance h.

(9 marks)

(b) Water discharges into the atmosphere through the device shown in **Figure Q4 (b)**. Determine the horizontal component of force at the flange required to hold the device in place.

(11 marks)

PART B: ANSWER ALL QUESTIONS

Q5 (a) Water flows steadily through a horizontal circular pipe. Sketch a graph of pressure drop against pipe length, within the fully developed region, that describes the pressure change through the pipe as the length increases.

(4 marks)

(b) Water flows from the container shown in **Figure Q5 (b)**. Determine the loss coefficient needed in the valve if the water is to come out and rise 0.57 m above the outlet pipe. The entrance is slightly rounded and the loss coefficient is 0.2. The loss coefficient of the elbow is 1.5. The viscosity of water is 1.0×10^{-3} N.s/m^2.

(16 marks)

Q6 (a) The aerodynamic drag of a new sports car is to be predicted at a speed of 80 km/hr at an air temperature of 25°C. Automotive engineers build a one fifth scale model of the car to test in a wind tunnel. It is winter and the wind tunnel is located in an unheated building; the temperature of the wind tunnel air is only about 5°C. Determine how fast the engineers should run the wind tunnel in order to achieve similarity between the model and the prototype. The density of air at 5° and 25° are 1.269 kg/m^3 and 1.184 kg/m^3, respectively. The viscosity of air at 5° and 25° are 1.754×10^{-5} kg/m.s and 1.849×10^{-5} kg/m.s, respectively.

(5 marks)

(b) The flow rate Q through an orifice plate is a function of pipe diameter D, pressure drop ΔP across the orifice, fluid density ρ and viscosity μ, and orifice diameter d. Using D, ρ and ΔP as repeating variables, express this relationship in dimensionless form.

(15 marks)

- END OF QUESTIONS –

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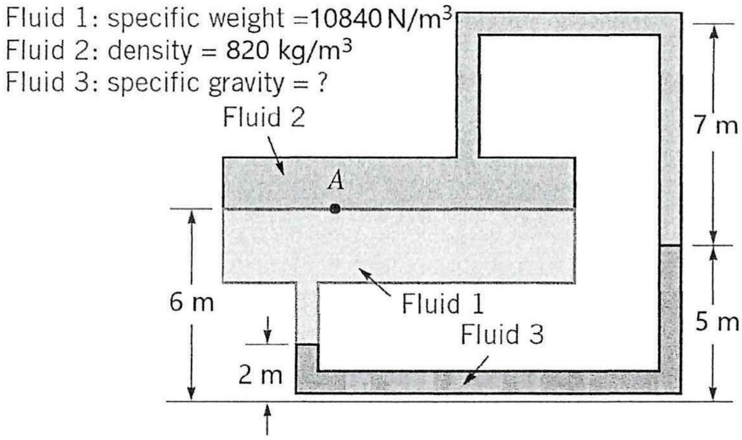

Figure Q1 (a)

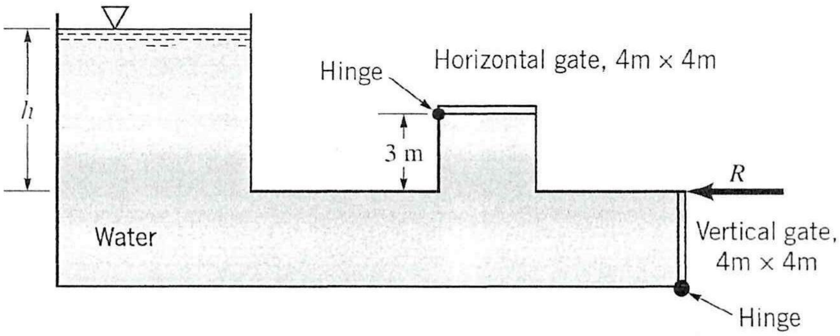

Figure Q1 (b)

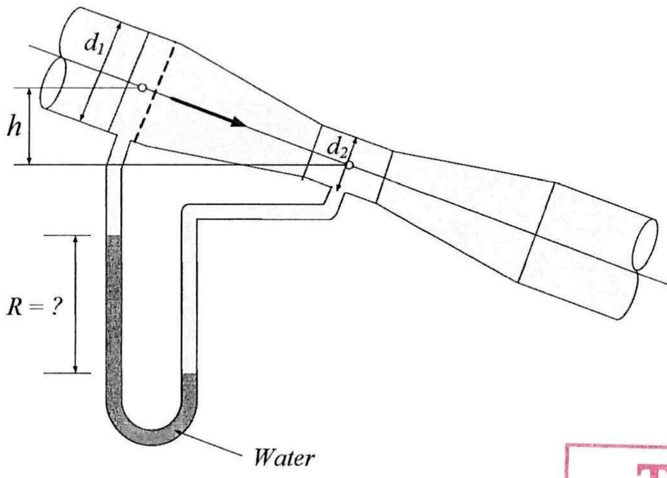

FIGURE Q3 (c)

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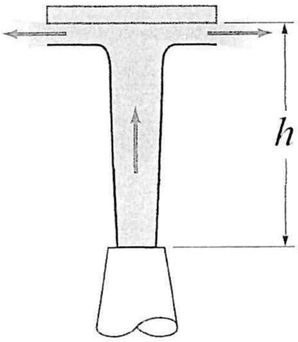

FIGURE Q4 (a)

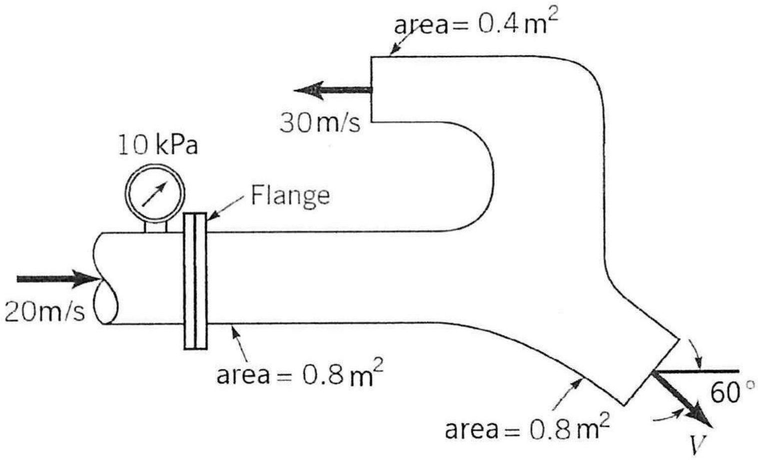

FIGURE Q4 (b)

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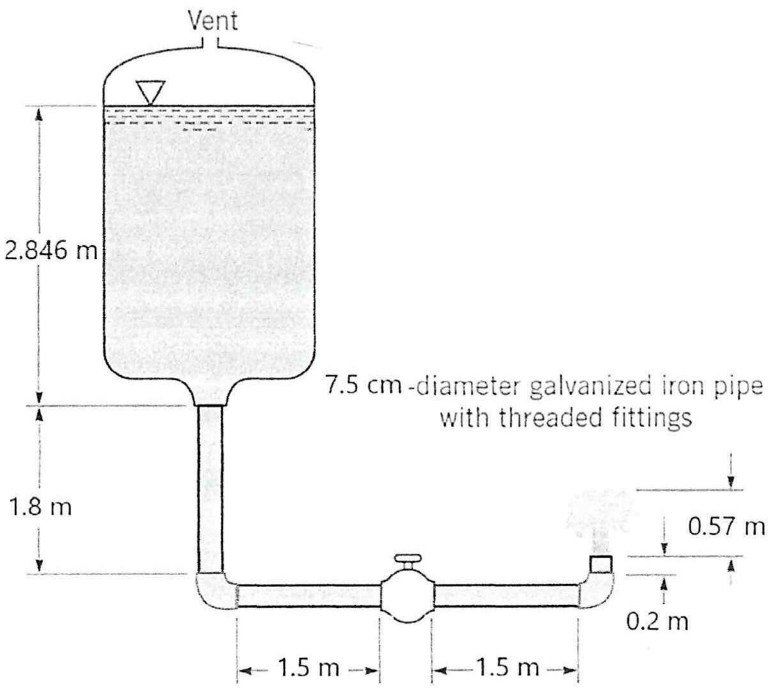
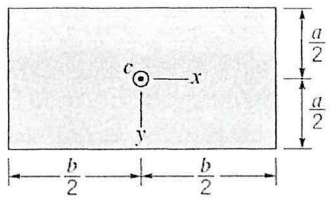


FIGURE Q5(b)

<u>Geometric properties of some common shapes</u>



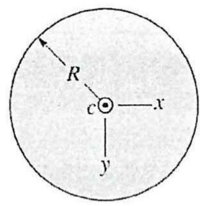
$A = ba$

$I_{xc} = \frac{1}{12}ba^3$

$I_{yc} = \frac{1}{12}ab^3$

$I_{xyc} = 0$

(*a*) Rectangle

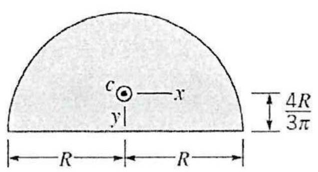


$A = \pi R^2$

$I_{xc} = I_{yc} = \frac{\pi R^4}{4}$

$I_{xyc} = 0$

(*b*) Circle



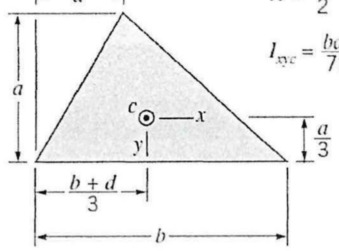
$A = \frac{\pi R^2}{2}$

$I_{xc} = 0.1098R^4$

$I_{yc} = 0.3927R^4$

$I_{xyc} = 0$

(*c*) Semicircle



$A = \frac{ab}{2}$ $I_{xc} = \frac{ba^3}{36}$

$I_{xyc} = \frac{ba^2}{72}(b - 2d)$

(*d*) Triangle

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Equivalent Roughness for New Pipes

	Equivalent Roughness, ε	
Pipe	**Feet**	**Millimeters**
Riveted steel	0.003–0.03	0.9–9.0
Concrete	0.001–0.01	0.3–3.0
Wood stave	0.0006–0.003	0.18–0.9
Cast iron	0.00085	0.26
Galvanized iron	0.0005	0.15
Commercial steel or wrought iron	0.00015	0.045
Drawn tubing	0.000005	0.0015
Plastic, glass	0.0 (smooth)	0.0 (smooth)

Moody Chart