Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	FLUID MECHANICS 1
COURSE CODE	:	BDA 20603
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	DECEMBER 2018 / JANUARY 2019
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 **SEVEN (7)** PAGES

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

Q1 (a) Compartments A and B of the tank shown in **Figure Q1 (a)** are closed and filled with air and a liquid with a specific gravity of 0.6. The pressure gage reads 3.5 kPa. Determine the manometer reading, h. The effect of the weight of the air is negligible.

(6 marks)

(b) A rectangular gate 2 m tall and 1 m wide in the side of an open tank is held in place by the force F as indicated in **Figure Q1 (b)**. The weight of the gate is negligible, and the hinge at O is frictionless. Determine the depth, h, if the resultant hydrostatic force of the oil ($SG_{oil} = 0.8$) and water acts 0.7 m above the bottom of the gate, i.e., it is collinear with the applied force F. Consider that the water level is at the same position as the hinge.

(8 marks)

Q2 (a) Use an appropriate diagram to explain

(i) the buoyancy force is equal to weight of the fluid displaced volume
(ii) relationship between Archimedes principle and floating body.

(5 marks)

(b) A wooden cylinder has diameter, length, and relative density of 10 cm, 40 cm and 0.6, respectively. A metal disc with diameter of 12 cm, 5 cm thickness and relative density of 4.5 is rigidly attached to the bottom end of the wooden cylinder. The combined wooden cylinder and metal disc is placed in the water with the axis is in vertical position.

(i) Draw the diagram to indicate all forces acting on the combined body as a floating body and all important points.
(ii) Calculate the height of submerged, h
(iii) Determine thickness of the metal disc in order the combined body is totally submerged.

(15 marks)

Q3 (a) If P_1 and P_2 are the pressure at inlet and throat of a venturi meter while the area of inlet and throat represented by A_1 and A_2, respectively. Show that volume flow rate of fluid through a venturi meter can be expressed as;

$$Q = A_2 \sqrt{\frac{2 . \Delta P}{\rho \left(1 - \frac{{A_2}^2}{{A_1}^2}\right)}}$$

(10 marks)

(b) Air at 105 kPa flow upward through a 6 cm diameter inclined duct at a rate of 65 L/s. The duct diameter is then reduced to 4 cm through a reducer. The pressure change across the reducer is measured by a water manometer. The elevation difference between the two points on the pipe where the two arms of the manometer are attached 0.20 m as shown in **Figure Q3(b)**. Determine the differential height between the fluid levels of the two arms of the manometer. Assuming that the gas constant of air is 0.287 kPa.m3/kg.K.

(10 marks)

Q4 (a) State the momentum equation for steady, one-dimensional flow for the case of no external forces and explain the physical significance of its terms.

(5 marks)

(b) A horizontal circular jet of air strikes a stationary flat plate as shown in **Figure Q4(b)**. The jet velocity is 40 m/s and the jet diameter is 0.03 m. If the air velocity magnitude remains constant as the air flows over the plate surface in the direction shown, determine

(i) the magnitude of F_A, the anchoring force required to hold the plate stationary.

(ii) the magnitude of F_A, the anchoring force required to allow the plate to move to the right at constant speed of 10 m/s.

(15 marks)

PART B: ANSWER **ALL QUESTIONS**

Q5 (a) Define the following terms

(i) Reynolds number

(ii) Relative roughness

(5 marks)

(b) Water at 15°C is to be discharged from a reservoir at a rate of 18 L/s using two horizontal cast iron pipes connected in series and a pump between them as shown in **Figure Q5(b)**. The first pipe is 20 m long and has a 6 cm diameter, while the second pipe is 35 m long and has a 4 cm diameter. The water level in the reservoir is 30 m above the centerline of the pipe. The pipe entrance is sharp-edged, and losses associated with the connection of the pump are negligible. Determine the total head losses of the two horizontal cast iron pipes. The density and viscosity of water at 15°C is 999.1 kg/m^3 are 1.138 x 10^{-3} kg/m.s. Also, the loss coefficient is $K_L = 0.5$ for a sharp-edged entrance. The roughness of cast iron pipes is $\varepsilon = 0.00026$ m.

(15 marks)

Q6 (a) State 4 criteria in selecting repeating variables in Buckingham's π analysis.

(4 marks)

(b) The drag force, F_D on a sphere located in a pipe through which a fluid is flowing is to determined experimentally as shown in **Figure Q7(b)**. Assume that the drag force, F_D is a function of the sphere diameter, d, the pipe diameter, D, the fluid velocity, V and the fluid density, ρ.

(i) Show that the dimensionless groups that exist is

$$\frac{F_D}{\rho V^2 d^2} = \emptyset \frac{D}{d}$$

(ii) An experiments using water indicate that for $d = 0.5$ cm, $D = 1.25$ cm and $V = 0.6$ m/s, the drag force is 6 x 10^{-3} N. Estimate the drag force on a sphere located in a 0.6 m diameter pipe through which water is flowing with a velocity of 1.8 m/s if the geometric similarity of sphere diameter is maintained.

(16 marks)

-END OF QUESTION –

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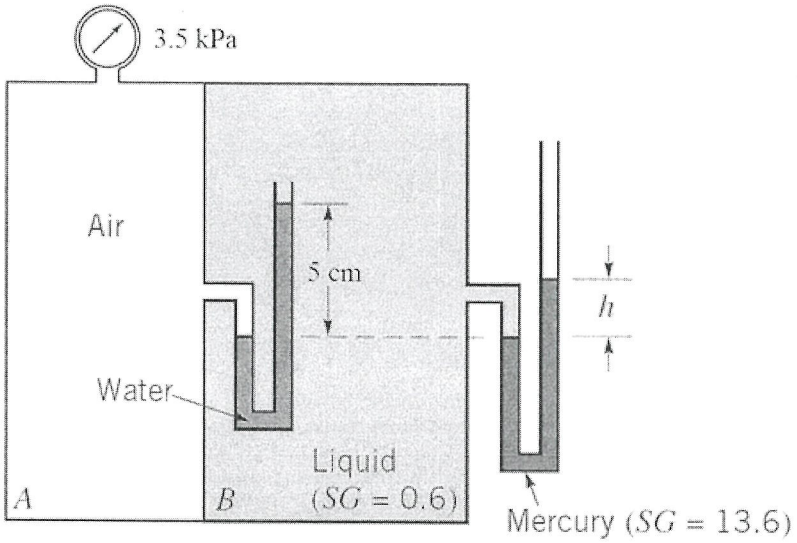

Figure Q1(a)

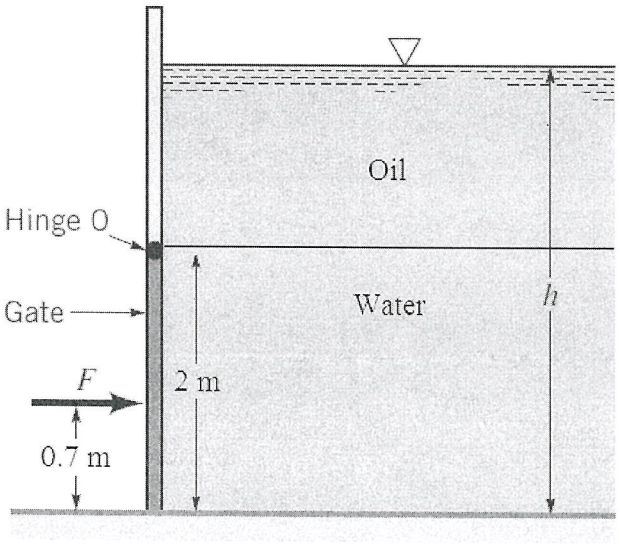

Figure Q1(b)

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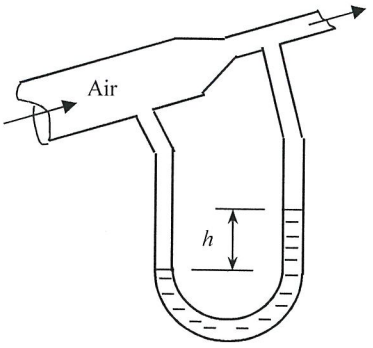

Figure Q3(b)

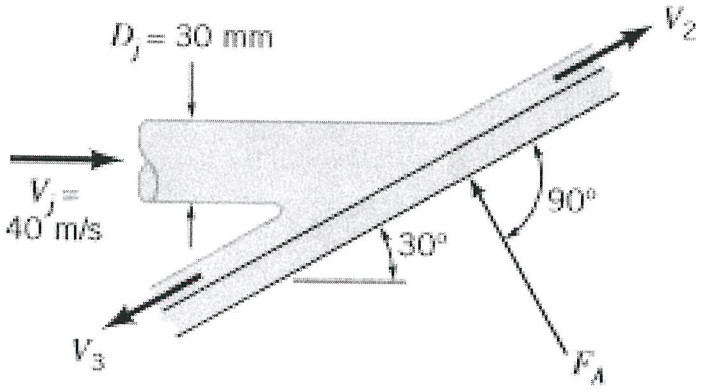

Figure Q4(b)

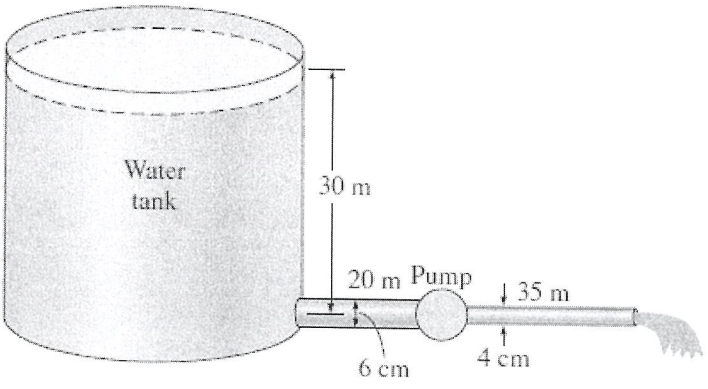

Figure Q5(b)

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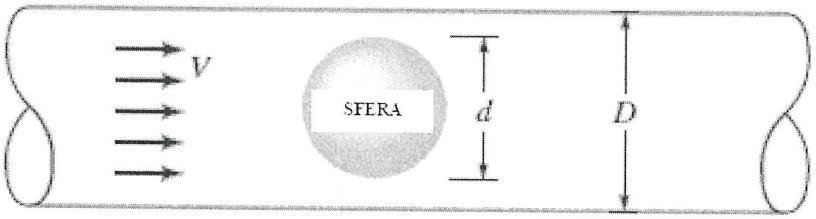
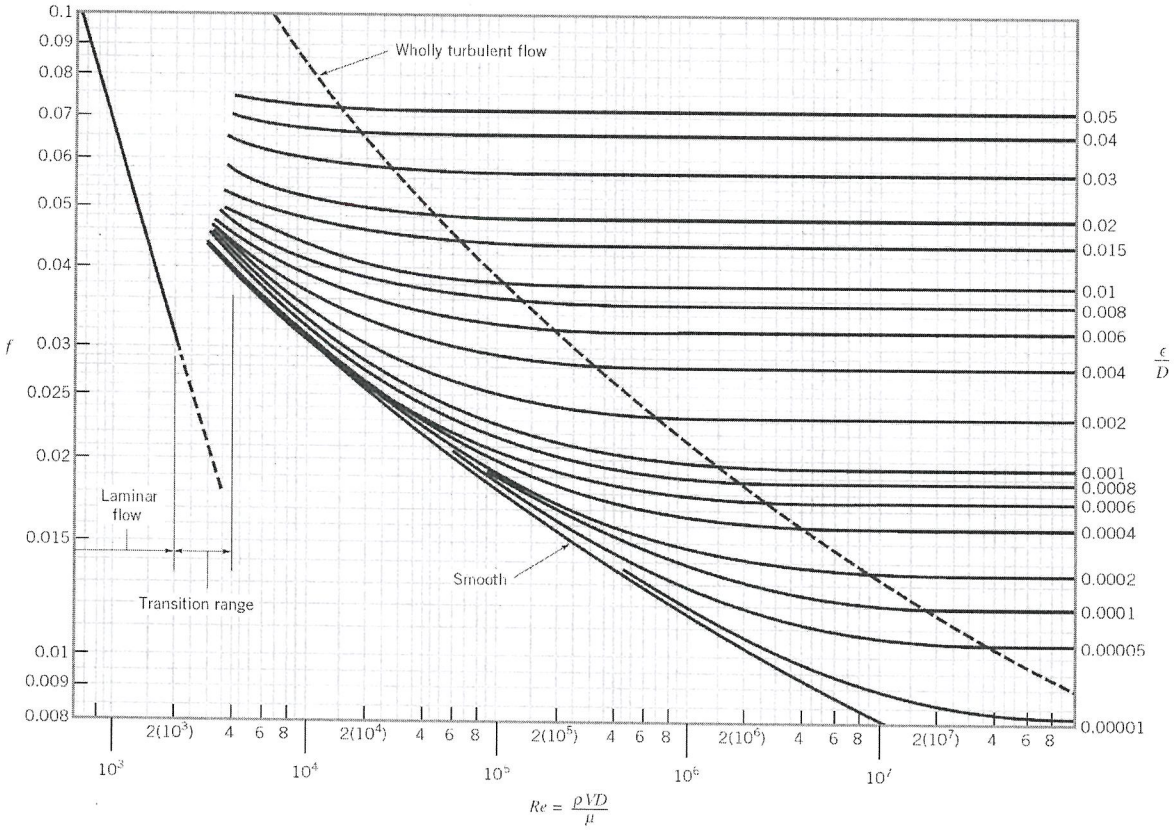


Figure Q6(b)



Moody Chart