Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	BNJ20203
PROGRAMME	:	2 BNG / 2 BNL / 2BNM
EXAMINATION DATE	:	JUNE/JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) Describe the meaning of no-slip condition and what causes it?

(4 marks)

(b) Discuss the difference between Newtonian and Non-newtonian fluids

(6 marks)

(c) A cylinder of 0.16 m in diameter is to be mounted in a stream of water in order to estimate the force on a tall chimney of 1 m diameter which is subject to wind of 33m/s. Calculate

(i) the speed of the stream necessary to give a dynamic similarity between the model and chimney

(5 marks)

(ii) the ratio of forces given data are as follow:
Chimney: $\rho = 1.12 kg/m^3$ $\mu = 1610^{-6}$ kg/ms
Model: $\rho = 1000 kg/m^3$ $\mu = 810^{-4}$ kg/ms

(10 marks)

Q2 (a) The pressure in the air gap is 8000 Pa gage. The tank is cylindrical as shown in **Figure Q2(a)**. Calculate the net hydrostatic force

(i) on the bottom of the tank

(4 marks)

(ii) on the cylindrical sidewall CC

(4 marks)

(iii) on the annular plane panel BB.

(5 marks)

(b) Balloons are often filled with helium gas because it weighs only about one-seventh of what air weighs under identical conditions shown in the **Figure Q2(b)**. The buoyancy force, which can be expressed as $F_b = \rho_{air} g V_{balloon}$, will push the balloon upward. If the balloon has a diameter of 10 m and carries two people, 70 kg each, determine the acceleration of the balloon when it is first released. Assume the density of air is $\rho_{air} = 1.16 kg/m^3$, and neglect the weight of the ropes and the cage.

(12 marks)

Q3 (a) The air velocity in the duct of a heating system is to be measured by a Pitot-static probe inserted into the duct parallel to flow shown in **Figure Q3(a)**. If the differential height between the water columns connected to the two outlets of the probe is 2.4 cm, determine

(i) the flow velocity

(5 marks)

(ii) the pressure rise at the tip of the probe if the air temperature and pressure in the duct are 45°C and 98 kPa, respectively (the gas constant of air is $R = 0.287$ kPa.m^3/kg.K.).

(5 marks)

(b) 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 Q3(b)**. Now, a 2 cm of diameter tap is opened.

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

(5 marks)

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

(5 marks)

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

(5 marks)

Q4 (a) Define the conservation of momentum principle. What can you say about the momentum of a body if the net force acting on it is zero? Is momentum a vector? If so, in what direction does it point?

(5 marks)

(b) Write 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)

(c) A reducing elbow shown in **Figure Q4(c)** is used to deflect water flow at a rate of 30 kg/s in a horizontal pipe upward by an angle of u = 45° from the flow direction while accelerating it. 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.

(15 marks)

Q5 (a) (i) Determine the Reynolds number for Glycerin at 25 °C when the velocity of the fluids flow inside the pipe having a diameter of 150 mm is 3.6 m/s. Given the density of the fluid, $\rho = 1258$ kg/m^3 and the dynamic viscosity, μ is 0.96 Pa.s or (kg/m.s) and the length of the pipe is 30 m.

(3 marks)

(ii) Characterize the type of the flow and calculate the energy loss inside the pipe if the velocity is increased to 4.0 m/s

(7 marks)

(b) A tank of water empties by gravity through a horizontal pipe into another tank as shown in **Figure Q5(b)**. There is a sudden enlargement in the pipe. At a certain time,

the difference in level is 3 m. Each pipe is 2 m long and has a friction coefficient, f = 0.005. The inlet loss coefficient is 0.3. Calculate the flow rate at this point.

(15 marks)

END OF QUESTION

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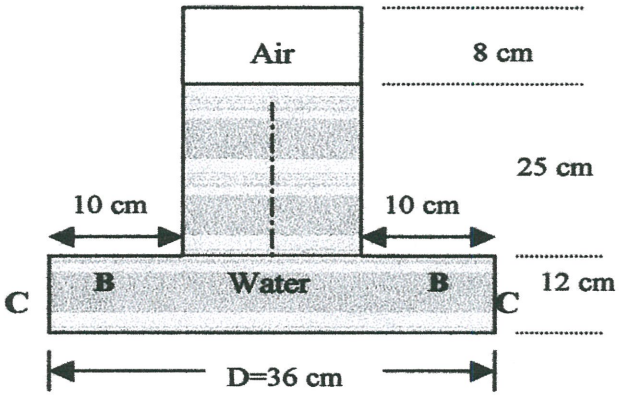

FIGURES Q2(a)

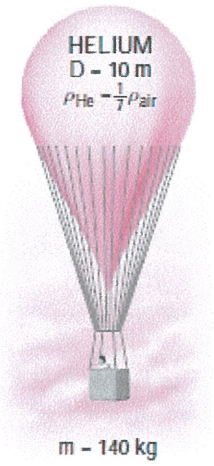

FIGURE Q2(b)

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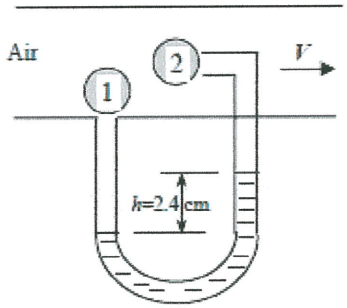
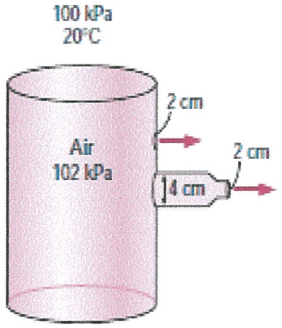


FIGURES Q3(a)



FIGURES Q3(b)

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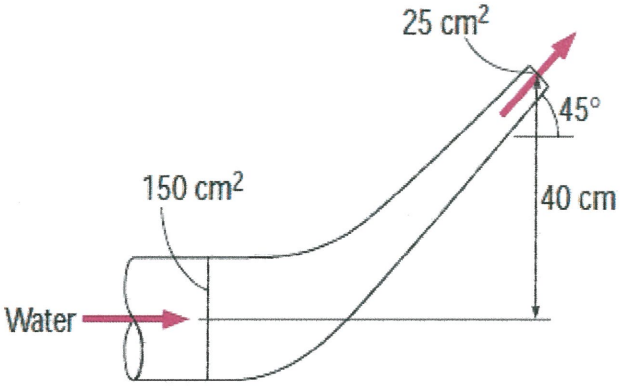
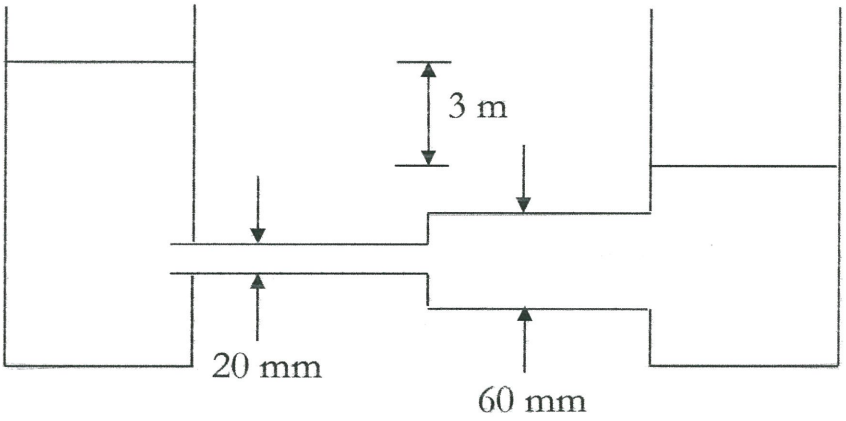


FIGURES Q4(c)



FIGURES Q5(b)