UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	**FLUID MECHANICS 1**
COURSE CODE	:	**BDA 1052/10502**
PROGRAMME	:	**BACHELOR OF MECHANICAL ENGINEERING WITH HONORS**
EXAMINATION DATE	:	**JUNE 2012**
DURATION	:	**2 ½ HOURS**
INSTRUCTION	:	**ANSWER FIVE (5) QUESTIONS ONLY FROM SIX (6) QUESTIONS.**

THIS QUESTION PAPER CONSISTS OF EIGHT (8) PAGES

Q1 (a) Express Pascal's Law. Give a real-world example of it.

(2 marks)

(b) Two chambers with the same fluid at their base are separated by a piston whose weight is 25 N, as shown in **Figure Q1(b)**. Calculate the gage pressures in chambers A and B.

(8 marks)

(c) A U-tube manometer in **Figure Q1(c)** measures the pressure difference between two points A and B in a liquid of density ρ_1. The U-tube contains mercury of density ρ_2. Calculate the difference of pressure if a = 1.5 m, b = 0.75 m and h = 0.5 m if the liquid at A and B is water and $\rho_2 = 13.6\rho_1$.

(10 marks)

Q2 (a) Explain why dams are much thicker at the bottom.

(2 marks)

(b) A dam has the cross-sectional profile composed of a vertical face with a circular curved section at the base as shown in **Figure Q2(b)**. Calculate the resultant force and its direction of application per unit width of this dam.

(6 marks)

(c) The two sides of a V-shaped water trough are hinged to each other at the bottom where they meet, as shown in **Figure Q2(c)**, making an angle of 45° with the ground from both sides. Each side is 0.75 m wide, and the two parts are held together by a cable and turnbuckle placed every 6 m along the length of the trough.

(i) Determine the tension in each cable when the trough is filled to the rim.
(ii) Determine the tension for the case of a partially filled trough with a water height of 0.4 m directly above the hinge.

(12 marks)

Q3 (a) Express Archimedes' Principle.

(2 marks)

(b) The hull of a boat has a volume of 150 m^3, and the total mass of the boat when empty is 8560 kg. Determine how much load this boat can carry without sinking.

(i) In a lake and
(ii) In seawater with a specific gravity of 1.03.

(18 marks)

Q4 (a) Describe stagnation pressure. Using an appropriate illustration, explain how it can be measured.

(8 marks)

(b) Water with ρ = 999.1 kg/m^3 and $\mu = 1.138\times10^{-3}$ kg/ms is drained from a large reservoir using two horizontal plastic pipes connected in series as shown in **Figure Q4 (b)**. The first pipe is 20 m long with a 10 cm diameter, while the second pipe is 35 m long with a 4 cm diameter. The water level in the reservoir is 18 m above the centerline of the pipe. The pipe entrance is sharp-edged (K_L = 0.5) and the contraction between the two pipes is sudden (K_L = 0.46). Take friction factor for the first pipe f_1 = 0.0196 and friction factor for the second pipe f_2 = 0.0162, determine the discharge rate of water from the reservoir.

(12 marks)

Q5 (a) Express the conservation of momentum principle. What can you say about the momentum of a body if the net force acting on it is zero?

(4 marks)

(b) Water flows at a rate of 1.0 m^3/s round a 45° contracting pipe bend which lies in a horizontal plane. The diameter at the bend entrance is 800 mm and at the exit 400 mm - as shown in **Figure 5(b)**.

(i) If the pressure at the entrance to the bend is 100 kN/m^2, what is the magnitude and direction of the force exerted by the fluid on the bend?
(ii) Comment on the reason why frictional losses may be neglected in this analysis.

(16 marks)

Q6 (a) What is the difference between a dimension and a unit? Give two examples of each.

(2 marks)

(b) Explain the law of dimensional homogeneity in simple terms.

(3 marks)

(c) A human-powered submarine has to be produced for a design competition. The overall length of the prototype submarine is 2.24 m, and it is expected to travel fully submerged through freshwater at 0.560 m/s at T = 15°C. A one-eighth scale model is to be built and tested in the wind tunnel as shown in **Figure Q6 (c)**. A shield surrounds the drag balance strut so that the aerodynamic drag of the strut itself does not influence the measured drag. The air in the wind tunnel is at 25°C and at standard atmosphere pressure. Determine the air speed that wind tunnel need to be run in order to achieve similarity.

Take, for water at T = 15°C and atmospheric pressure, $\rho = 999.1$ kg/m^3 and $\mu = 1.138 \times 10^{-3}$ kg/ms. For air at T = 25°C and atmospheric pressure, $\rho = 1.184$ kg/m^3 and $\mu = 1.849 \times 10^{-5}$ kg/ms.

(4 marks)

(d) When fluid in a pipe is accelerated linearly from rest, it begins as laminar flow and then undergoes transition to turbulence at a time t_{tr} which depends upon the pipe diameter D, fluid acceleration a, density ρ, and viscosity μ. Arrange this into a dimensionless relation between t_{tr} and D.

(11 marks)

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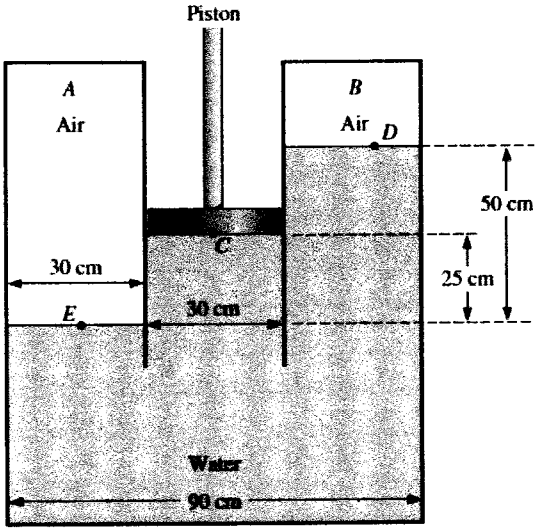

Figure Q1 (b)

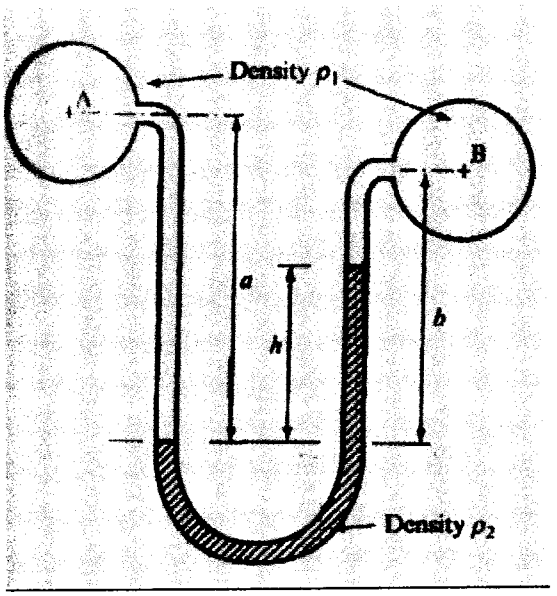

Figure Q1 (c)

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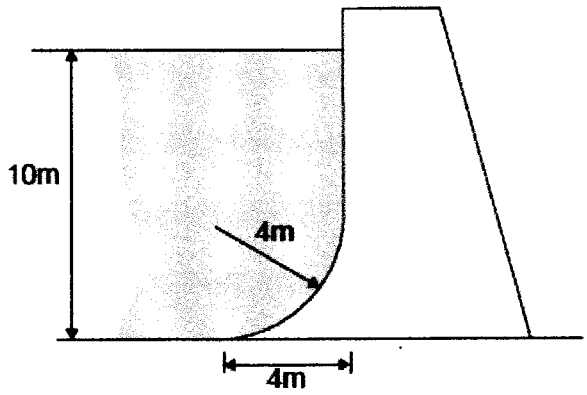

Figure Q2 (b)

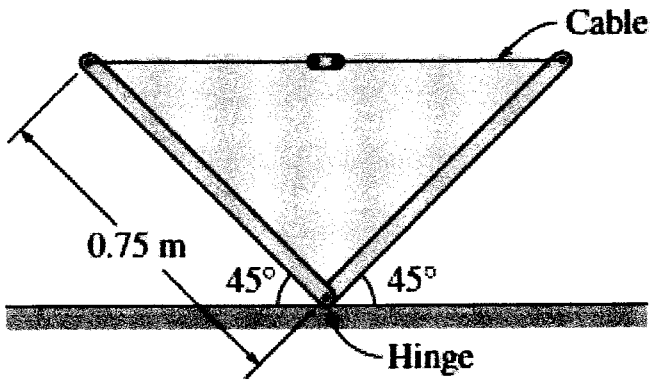

Figure Q2 (c)

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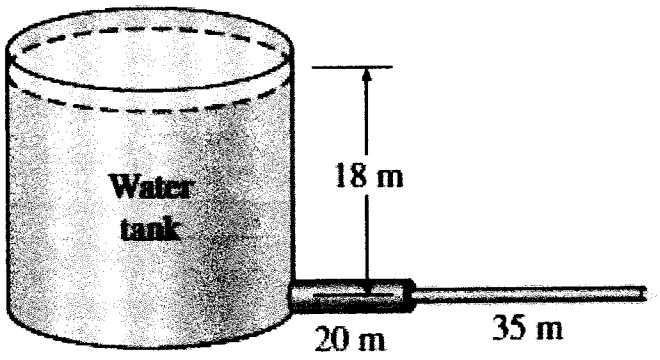

Figure Q4 (b)

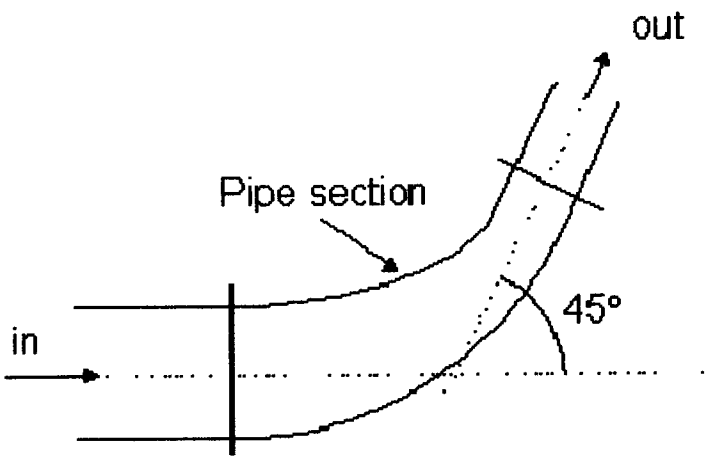

Figure Q5 (b)

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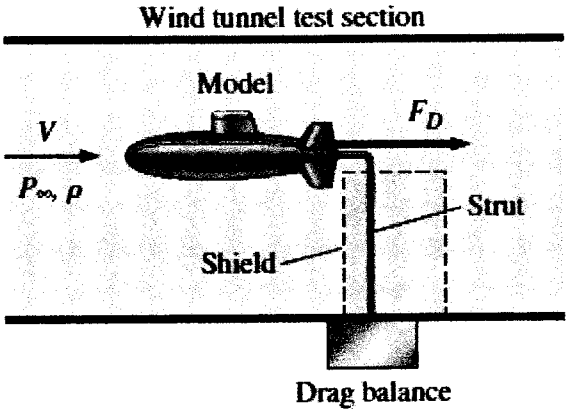

Figure Q6 (c)