UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	FLUID MECHANICS 1
COURSE CODE	:	BDA 20603 / BDA10502
PROGRAMME	:	2 BDD
EXAMINATION DATE	:	JUNE 2015 / JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY FROM SIX (6) QUESTIONS.

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

Q1 (a) Define Newtonian fluid and give an example of non-Newtonian fluids.

(5 marks)

(b) A 1.2-mm diameter tube is inserted into an unknown liquid whose density is 960kg/m^3, and it is observed that the liquid rises 5-mm in the tube, making a contact angle of 15°. Determine:

(i) the surface tension of the liquid; and

(7 marks)

(ii) the capillary rise of the liquid, if the liquid is kerosene with surface tension 0.028N/m and density is 820 kg/m^3.

(8 marks)

Q2 (a) A gasoline line is connected to a pressure gauge through a double-U manometer, as shown in **Figure Q2 (a)**. If the reading of the pressure gage is 330kPa. Determine the gauge pressure of the gasoline line.

(8 marks)

(b) A cylindrical tank is fully filled with water as shown in **Figure Q2 (b)**. In order to increase the flow from the tank, an additional pressure is applied to the water surface by a compressor. For $P_0 = 0$, $P_0 = 3$ bar, $P_0 = 10$ bar, calculate the hydrostatic force on the surface A exerted by water.

(12 marks)

Q3 (a) A fluid with density, ρ flow through the venturi meter. 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;

$$Q = A_2 \sqrt{\frac{2(P_1 - P_2)}{\rho(1 - A_2^2 / A_1^2)}}$$

(10 marks)

(b) Water flows at a rate of 0.035 m^3/s in a horizontal pipe whose diameter is reduced from 15 cm to 8 cm by a reducer. If the pressure at the centerline is measured to be 470 kPa and 440 kPa before and after the reducer, respectively, determine the irreversible head loss in the reducer. Take the kinetic energy correction factors to be 1.05.

(10 marks)

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

(4 marks)

(b) A 60 kg ice skater is standing on ice with ice skates (negligible friction) as shown in **Fig. 4 (b)**. She is holding a flexible hose (essentially weightless) that directs a 2 cm diameter stream of water horizontally parallel to her skates. The water velocity at the hose outlet is 10 m/s. If she is initially standing still, determine:

(i) the velocity of the skater and the distance she travels in 5 s; and

(12 marks)

(ii) how long it will take to move 5 m and the velocity at that moment.

(4 marks)

Q5 (a) Someone claims that the average velocity in a circular pipe in fully developed laminar flow can be determined by simply measuring the velocity at $R/2$ (midway between the wall surface and the centerline).

(i) what is your opinion about the statement, do you agree or not; and

(1 marks)

(ii) explain your opinion.

(3 marks)

(b) Water at 10°C ($\rho = 999.7$ kg/m^3 and $\mu = 1.307 \times 10^{-3}$ kg/m · s) is flowing steadily in a 0.20 cm diameter, 15 m long pipe. In the fully developed laminar flow region, the velocity at $R/2$ (midway between the wall surface and the centerline) is measured to be 1.8 m/s. Determine the velocity at the center of the pipe at the average velocity of the flow.

(4 marks)

(c) For the conditions stated in **Q5 (b)**, determine the pressure drop, the head loss, and the pumping power requirement to overcome this pressure drop.

(12 marks)

Q6 (a) List and describe three necessary conditions for complete similarity between a model and prototype.

(6 marks)

(b) A team of student is to design a human-powered submarine. The overall length of the prototype submarine is 2.24 m, and it is designed so that it can travel fully submerged through water at 0.560 m/s. The water is freshwater (a lake) at $T = 15$°C. The design team builds a one-eighth scale model to test in their university's wind tunnel. 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 atmospheric pressure. At what air speed do they need to run the wind tunnel in order to achieve similarity?

(7 marks)

(c) The students measure the aerodynamic drag force on their model submarine in the wind tunnel as shown in **Figure 6(c)** to be 2.3 N. They are careful to run the wind tunnel at conditions that ensure similarity with the prototype. Estimate the drag force on the prototype submarine.

(7 marks)

- END OF QUESTION –

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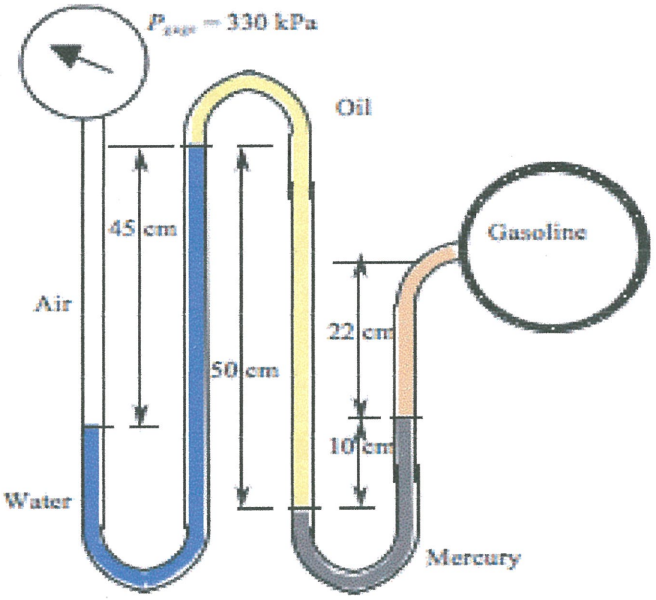

Figure Q2 (a)

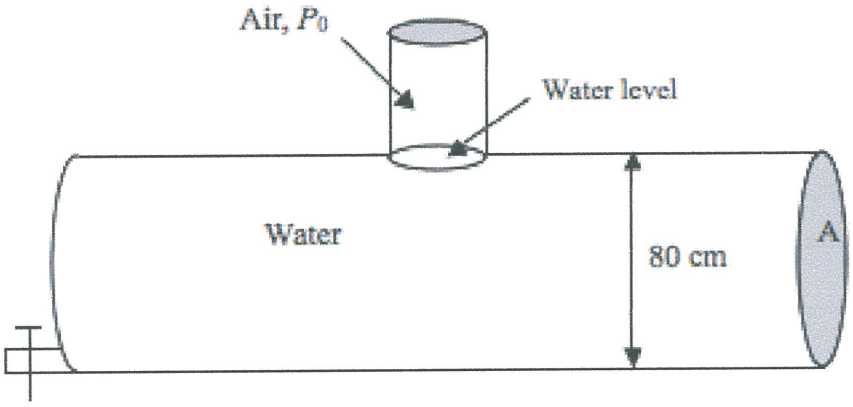

Figure Q2 (b)

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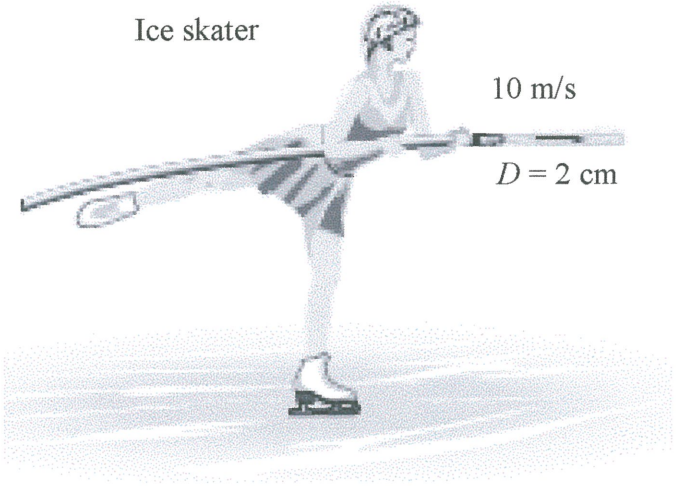

Figure Q4 (b)

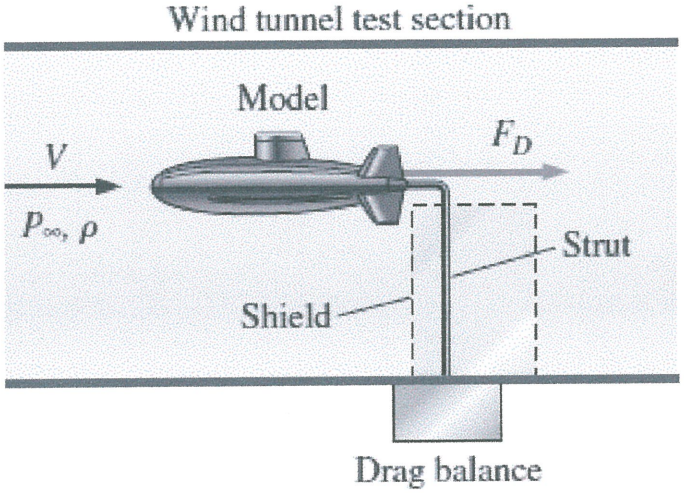

Figure Q6 (c)