Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	BNJ20203
PROGRAMME CODE	:	BNG/BNH/BNK/BNL/BNM
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 (a) (i) Define the meaning of no-slip condition of a fluid flow.

(2 marks)

(ii) Distinguish the difference between internal and external flow with example.

(3 marks)

(b) The pressure in a balloon is depends on the temperature of air in the balloon. The gage pressure reads 1.4 bar when the air temperature is at 25°C. If the volume of the balloon is 0.014m^3, find the pressure rise in the balloon if the temperature of air in the balloon is 36°C. Assume the atmospheric pressure to be 1.0 bar. Assume the air is an ideal gas and volume of the balloon remain constant.

(5 marks)

(c) A round viewing window of diameter, d = 0.8m is situated in a large tank of seawater (specific gravity, SG = 1.03). The top of the window is 1.2m below the water surface, and the window is gled at 60° with respect to horizontal as shown in **Figure Q1 (c)**.

(i) Find the hydrostatic force acting on the window and the centroid, y_c.

(8 marks)

(ii) Locate the center of pressure.

(2 marks)

Q2 (a) (i) Define metacenter and its effects on the stability of a submerged or floating

(3 marks)

(ii) A metal part (object 2) is suspended by a thin cord from a floating wood block (object 1) as shown in **Figure Q2 (a) (ii)**. The wood block has a specific gravity, SG = 0.3 and dimension 60 x 60 x 10 mm. The metal part has a volume 7100 mm^3. Draw free body diagram and find the tension, T in the cord and mass, m2 of the metal part. Given the water at 15°C specific weight, γ = 9800 N/m^3. Compare the tension in the cord value and the weight of metal part.

(7 marks)

(b) (i) U-tube manometer is a pressure measuring device, one of it is the inclined u-tube manometer. List out the specific use of it.

(2 marks)

(ii) The tank is fill with oil has specific gravity, SG=0.8 and the tank is pressurized with air. Evaluate the pressure of air in the tank if l_1=40cm, l_2=100cm, and l_3=80cm as shown in **Figure Q2 (b) (ii).** Given the specific weight, γ for mercury is 133,000 N/m^3 and for water is 9810 N/m^3. List assumption used in the calculation.

(3 marks)

(c) Surface tension experiment is carried out by inserting a tiny tube with diameter (d=1.2mm) into an unknown solution in a beaker. The solution have contact angle 15° and the surface tension, σ is 0.0836 N/m and the density of the solution, ρ is 1150kg/m^3. Sketch the forces acting on the liquid column and determine the rise of solution in the tiny tube.

(5 marks)

Q3 (a) (i) Bernoulli's equation provides the relationship between pressure, velocity and elevation along a streamline. Outline **FOUR (4)** assumptions made in deriving the Bernoulli's equation.

(2 marks)

(ii) State the Bernoulli equation in **THREE (3)** different ways using energies, pressures and heads.

(3 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 pipe inclined at 45° to the horizontal as shown in **Figure Q3 (c)** converges over a length l of 2 m from a diameter d_1 of 200 mm to a diameter d_2 of 100 mm at the upper end. Oil of relative density 0.9 flows through the pipe at a mean velocity C_1 at the lower end of 2 m/s. Find the pressure difference across the 2 m length ignoring any loss of energy, and the difference in level that would be shown on a mercury manometer connected across this length. The relative density of mercury is 13.6 and the leads to the manometer are filled with the oil.

(10 marks)

Q4 (a) A 600 mm diameter pipeline carries water under a head of 30 m with a velocity of 3 m/s. This water main is fitted with a horizontal bend which turns the axis of the pipeline through 75 (i.e. the internal angle at the bend is 105). Calculate the resultant force on the bend and its angle to the horizontal

(7 marks)

(b) Water at 10°C (ρ = 999.7 kg/m^3 and μ = 1.307 x 10^{-3} kg/m · s) is flowing steadily in a 0.20 cm diameter, 15 m long pipe at an average velocity of 1.2 m/s. Determine

(i) The pressure drop

(2 marks)

(i) The head loss

(1 mark)

(c) A tank of water empties by gravity through a horizontal pipe into another tank as shown in **Figure Q4 (c)**. 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.

(10 marks)

Q5 (a) Show that the Reynolds number for flow in a circular pipe of diameter D can be expressed as $Re = 4m/\pi D\mu$.

(4 marks)

(b) **Figure Q5 (b)** shows two possible locations for a water pump in a piping system that pumps water from the lower tank to the upper tank. Identify which location is better. Please justify your answer

(6 marks)

(c) A centrifugal pump is to be placed above a large, open water tank, as shown in **Figure Q5 (c)**, and is to pump water at a rate of. At this flowrate the required net positive suction head, is 15 m, as specified by the pump manufacturer. The water temperature is 80°C and atmospheric pressure is 1 atm. Assume that the major head loss between the tank and the pump inlet is due to filter at the pipe inlet having a minor loss coefficient $K_L = 20$. Other losses can be neglected. The pipe on the suction side of the pump has a diameter of 4 mm. Determine the maximum height, that the pump can be located above the water surface without cavitation.

(10 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER / SESSION	: SEM I / 2019/2020	PROGRAMME	: BNG/BNH/BNK/BNL/BNM
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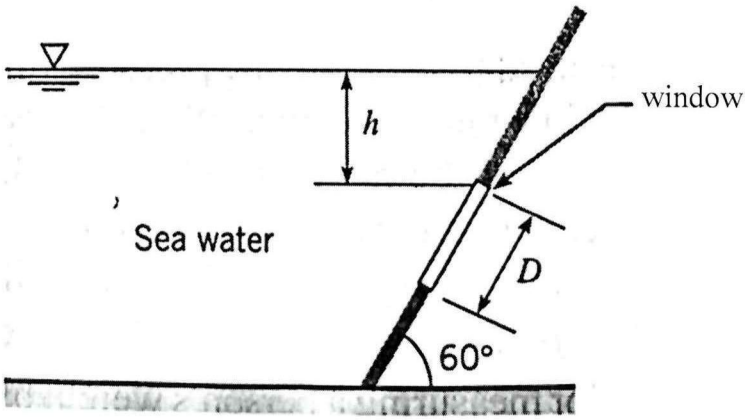

FIGURE Q1 (c)

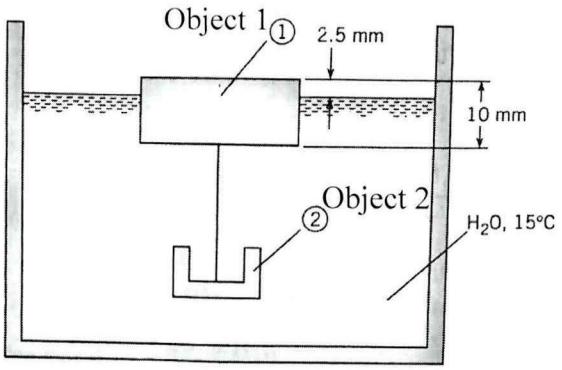

FIGURE Q2 (a)(ii)

FINAL EXAMINATION

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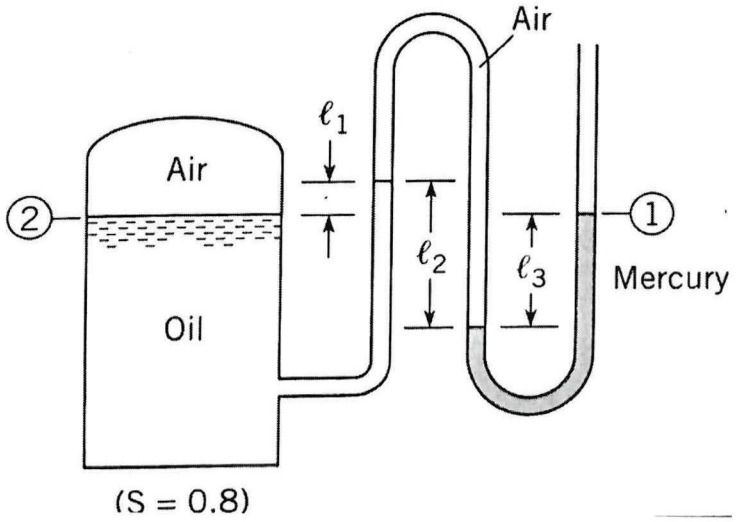

FIGURE Q2(b) (ii)

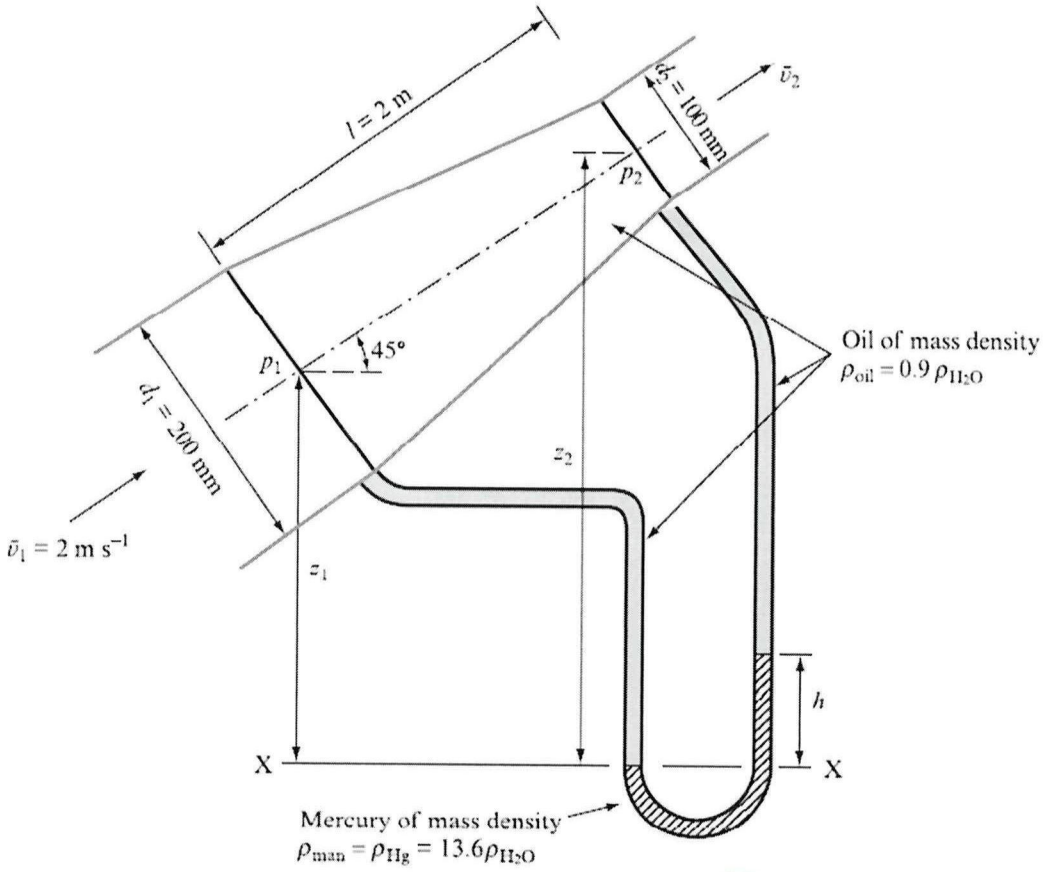

FIGURE Q3 (c)

FINAL EXAMINATION

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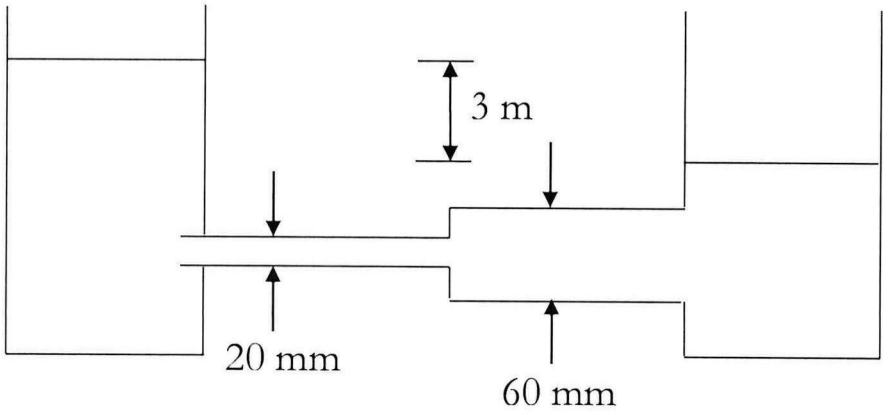
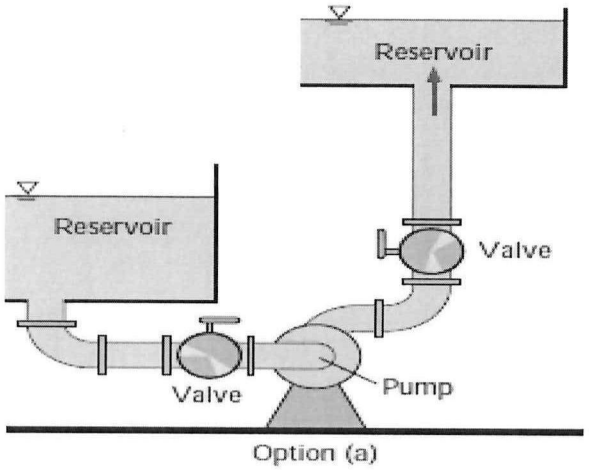


FIGURE Q4 (c)



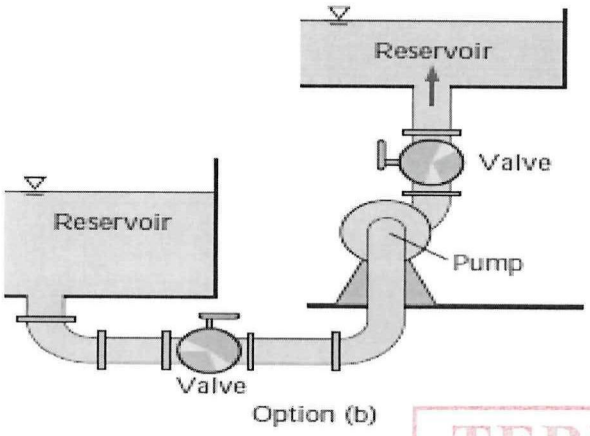


FIGURE Q5 (b)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2019/2020
COURSE NAME : FLUID MECHANICS
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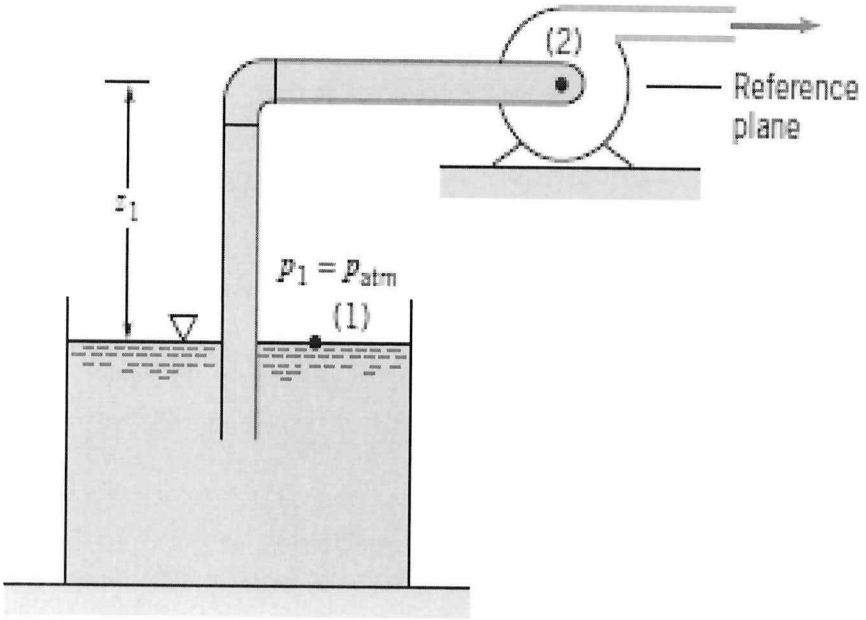

FIGURE Q5 (c)

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List of formula:

1. $\boldsymbol{Major\ loss, h_{f1} = \frac{f_1 l v^2}{2\,gD}}$

2. $\boldsymbol{Minor\ loss, h_{L1} = \frac{K_{L1} v^2}{2\,g}}$

3. **Sudden enlargement,** $\boldsymbol{K_{L2} = \left[1 - \left(\frac{D_1}{D_2}\right)^2\right]^2}$