UNIVERSITI
TEKNOLOGI
PETRONAS

FINAL EXAMINATION
MAY 2024 SEMESTER

COURSE	:	**PFB2013/PEB2013 - FLUID MECHANICS**
DATE	:	**12 AUGUST 2024 (MONDAY)**
TIME	:	**9:00 AM - 12:00 NOON (3 HOURS)**

INSTRUCTIONS TO CANDIDATES

1. Answer **ALL** questions in the Answer Booklet.
2. Begin **EACH** answer on a new page in the Answer Booklet.
3. Indicate clearly answers that are cancelled, if any.
4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions, if any.
5. **DO NOT** open this Question Booklet until instructed.

Note :

i. There are **SIX (6)** pages in this Question Booklet including the cover page and the Appendix.

ii. **DOUBLE-SIDED** Question Booklet.

1. a. Explain (i) fluid at rest, and (ii) pressure distribution in the fluid, with the aid of a diagram.

[7 marks]

b. Explain Buoyant Force with a diagram.

[5 marks]

c. A classic U-tube manometer as shown in **FIGURE Q1** has one of its ends open and a 2 atm gas on the other. When mercury (gage fluid) of density 13,600 kg/m^3 is added to the manometer, the top of the mercury column on the right, h_2 is 40 cm higher than the mercury column on the left. Calculate the atmospheric pressure that the manometer is exposed to, in atm. State all assumptions.

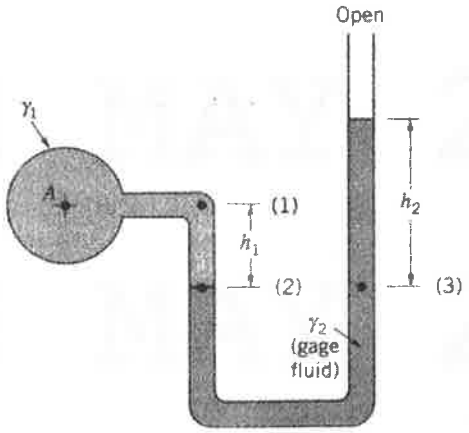

FIGURE Q1 : U-tube manometer

[12 marks]

2. a. Dimension of fluid characteristics can be described by using the primary quantities. Convert the velocity, force and area into primary quantities.

[6 marks]

b. Explain **FOUR (4)** disadvantages of piezometer.

[12 marks]

c. A cylindrical tank contains 350 kg of a liquid whose specific gravity is 1.5. Determine the volume of liquid in the tank. If the tank is replaced with a rectangular-shaped tank, determine the volume of the liquid.

[8 marks]

3. a. A horizontal, cylindrical hose with a radius of 2 cm is used to transfer drilling fluid at 2 ms^{-1}. At the end of the hose is a nozzle with a radius of 1 cm. With an aid of a diagram, determine the velocity of drilling fluid at the nozzle. If the drilling fluid is going to be transferred into a 300 m^3 tank, determine the time taken to fill the tank. State the term of the principle used, which is commonly used to describe a non-deforming control volume .

[13 marks]

b. **FIGURE Q3** shows a hose of area 0.01 m^2 is connected to a nozzle of area 0.003 m^2. A pressure gage is installed at the hose. Air flows inside the hose into the atmosphere through the nozzle and strikes a vertical plate. If a horizontal force of 12 N is required to hold the vertical plate in place, evaluate the possible gage reading.

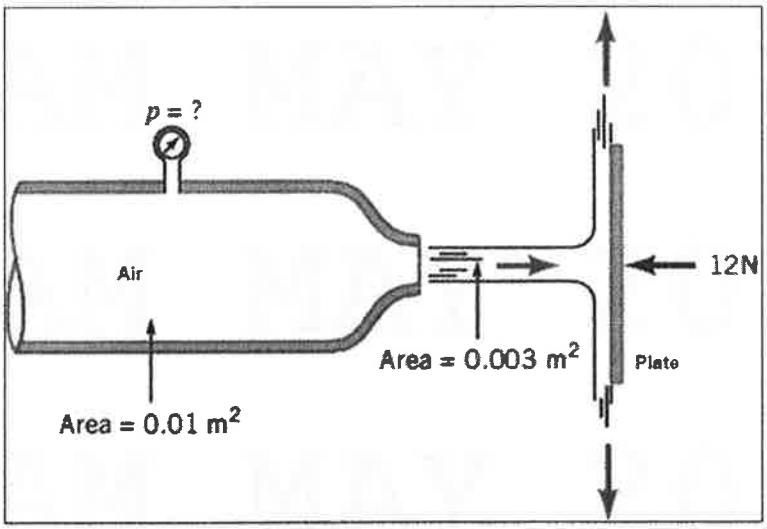

FIGURE Q3 : A hose with nozzle

[13 marks]

4. a. A rigid tank contains air at a pressure of 620 kPa and temperature of 15°C. Determine the change in the pressure when the temperature is increased to 43°C.

[4 marks]

b. A 10 cm^3 piece of wood and 10 cm^3 piece of metal are placed in a large water tank. The water tank is tilted by 5 degree upwards. With an aid of diagrams, justify the location of center of gravity and center of buoyancy acting on the wood and the metal. Suggest between the two forces acting on the wood and the metal, which one is greater.

[8 marks]

c. **FIGURE Q4** shows a jet of water coming out from nozzle of a stainless-steel tank. The tank is filled with water at the bottom and oil at the top. The specific gravity of the oil is 0.88. If the oil depth is 4 m and the diameter of the nozzle is 50 mm, determine the flow rate of the water jet. State all assumptions.

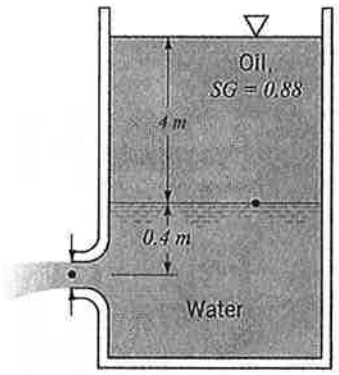

FIGURE Q4 : A tank with water jet

[12 marks]

- END OF PAPER -

APPENDIX I

Simple conversion and formulas:

$1 \text{ atm} = 101.3 \text{ kPa}$

$F_x = \rho A V^2$

$PV = nRT$

$P_1 = \rho gh + P_2$

$$\sum \dot{m}_{in} = \sum \dot{m}_{out}$$

$$\sum \dot{Q}_{in} = \sum \dot{Q}_{out}$$

$Q\ (m^3/s) = \text{Volume} \times \text{velocity}$

$$\text{Specific gravity} = \frac{\rho_{\text{substance}}}{\rho_{\text{water}}}$$

$$P_1 + \frac{1}{2}\rho V_1^2 + \gamma h_1 = P_2 + \frac{1}{2}\rho V_2^2 + \gamma h_2$$