KENYATTA UNIVERSITY

EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN GAS AND PETROLEUM ENGINEERING

<u>EPL202: FLUID MECHANICS I</u>

1ST SEMESTER 2023/2024 **TIME: 2 HOURS**

<u>INSTRUCTIONS:</u>

- **This paper contains FIVE questions**
- **Question ONE is COMPULSORY and carries 30 marks**
- **Attempt question ONE and any TWO of the remaining FOUR questions**
- **The remaining FOUR questions carry 20 marks each.**

QUESTION ONE (COMPULSORY QUESTION – 30 MARKS)

(a) Distinguish between Absolute and Gauge pressures. (2 marks)

(b) (i) What is manometre? (2 marks)

(ii) In Fig. 1, fluid P is air and fluid Q is oil of density 800 kg/m^3; h_1=300mm and h_2=50mm

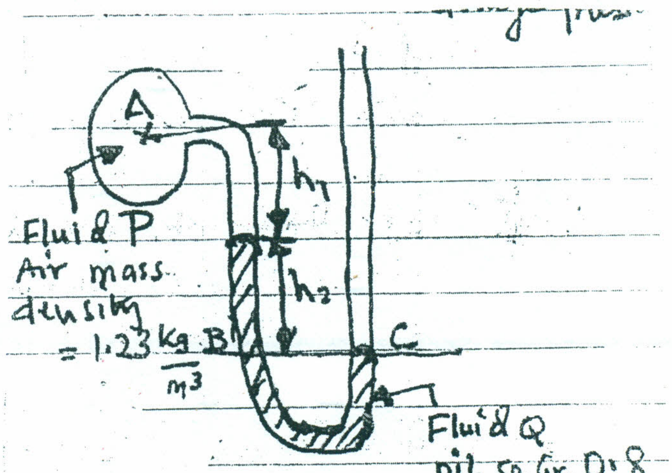


Fig 1

(i) Calculate the gauge pressure of A in mm of water (4 marks)

(c) Concisely describe the development of vapour pressure in a fluid at rest in an enclosed container. (4 marks)

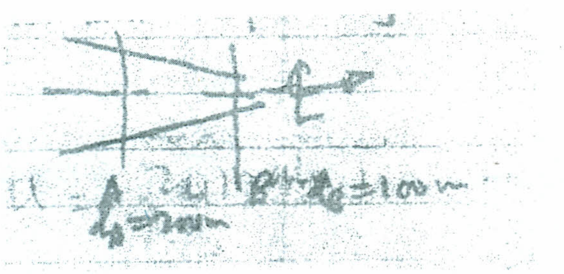
(d) Describe the physical structure and mode of operation in simple mercury barometer. (5 marks)

(e) Distinguish between the hydraulic terms

(i) Centre of area (1 mark)

(ii) Centre of pressure (1 mark)

(f) Water is flowing through a horizontal taping pipe AB (Fig.2) at the rate of 156 litres per second. The diameter at A and B are 200mm and 100mm respectively. Determine the force exerted due to the change in pipe cross section. (4 marks)



QUESTION TWO (20 MARK)

(a) A flat circular of radius r_m is vertically and completely immersed in water such that its circumference is tangential to water surface. Working from first principles show that the:

(i) total time on one side of the plate (P) $= \pi e g r^3$

where e = mass density of the liquid (kg/m^3)

g = acceleration due to gravity (m/sec^2)

r= radius of the plate (m) (4 marks)

(ii) depth of the centre of pressure $\left(\bar{h}\right)$ is $\left(\frac{5r}{4}\right)$ vertically below the free surface. (6 marks)

(b) A flat circular plate of radius 07m is vertically and completely immersed in water such that its circumference is tangential to the water surface.

Calculate the:

(i) Total hydrostatic force acting on one of its faces (4 marks)

(ii) Vertical depth of the centre of pressure below the surface. (6 marks)

QUESTION THREE (20 MARKS)

(a) Water is flowing through a pipe line 0.3m diameter, 36m above the sea level at 0.3393 m^2/sec under a pressure of 410 KN/m^2.

Determine the total energy head of the water above the sea level. (6 marks)

(b) The diameter of a pipe changes gradually from 150mm at a point A 6m above datum, to 75mm at B, 3m above datum. The pressure at B is 35.3 KN/m^2 and the velocity of flow is 19.4 m/sec.

Determine the pressure at A, neglecting all losses. (14 marks)

QUESTION FOUR (20 MARKS)

(a) Show that the discharge through an inclined venturimeter is independent of inclination but varies with pressure head difference. (8 marks)

(b) A venturimeter with a throat 100mm in diametric fitted in a pipe 250mm diameter is used to measure the discharge of oil of specific gravity 0.9 which is flowing at the rate of 0.1 m^3/sec.

The inlet and outlet of the meter are connected differentially to a U-tube manometer containing mercury of specific gravity 13.6. The coefficient of discharge for the meter is 0.95.

Determine the difference in the mercury levels in the manometer. (12 marks)

QUESTION FIVE (20 MARKS)

(a) What is the basic difference between small and large orifices? (2 marks)

(b) Show that the discharge (Q) through a trapezoidal open channel is given by:

$$Q = 2.953 C d H^{3/2}\left[B + \frac{4}{5}\tan\theta H\right]$$

Where C_d = coefficient of discharge

H = depth of water

B = Breadth of the trapezium

θ= angle of inclination of the slanting sides to the horizontal.

Work from first principles and explain the meaning of al symbols used.

(12 marks)

(c) A V-notch is required to convey 0.425 m^3/sec of water under a head of 0.61m.

Calculate the included angle for the notch in degrees

Assume C = 0.61 (6 marks)