MACHAKOS UNIVERSITY

University Examinations for 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATIONS FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EMM 204: FLUID MECHANICS II

DATE: **TIME:**

INSTRUCTIONS

This paper contains FIVE questions
Question ONE is **compulsory** and carries 30 Marks.
Questions TWO – FIVE carries 20 Marks each.
Answer question **ONE** and any other **TWO** questions**.**

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Define the following terms.

i) Absolute pressure (2 marks)

ii) Compressibility (2 marks)

iii) Vapour pressure (2 marks)

b) i) What is a manometer? (3 marks)

ii) Figure 1 shows a U-tube mercury manometer in which fluid A is water and fluid B is mercury where a = 1.5 m and h = 1.16 m.

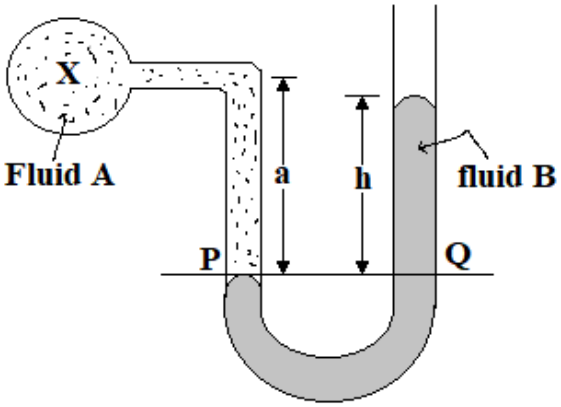

Figure 1

Calculate the gauge pressure at X in kN/m^2. **(**4 marks)

iii) Determine the absolute pressure at X if the atmospheric pressure is 103.5 kN/m^2. (4 marks)

c) Consisely describe the:

i) Physical structure (3 marks)

ii) Mode of operation of Bourdon gauge (4 marks)

d) i) State Pascal's law (1 mark)

ii) A force of 900 N is applied to the smaller cylinder of a hydraulic jack. The diameter of thepiston is 50 mm while that of the ram is 150 mm. Calculate load lfted by the jack. (5 marks)

QUESTION TWO (20 MARKS)

a) Distinguish between:

i) Centre of area

ii) Centre of pressure (2 marks)

b) A circular plate is vertically and completely submerged in a liquid. Determine the:

i) Total force acting on its onr face in terms of mass density of the liquid, acceleration due to gravity, surface area of the plate and the vertical depth of the center of area below the surface (3 marks)

ii) Vertical depth of its centre of pressure below the surface in terms of the vertical depth of its centre of area and its radius of gyration. . (5 marks)

c) A circuar laminar of diameter 1.6 m is vertically immersed in water such that its top edge is 1.0 m below the water surface. Calculate:

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

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

QUESTION THREE (20 MARKS)

a) Derive the Bernoulli's equation for an incompressible immiscible fluid by momentum consideration method. **(**10 marks)

b) A pipe 300 m long tapers from 1.2 m diameter to 0.6 m in diameter at its other end and slopes downward 1 in 100. The pressure at the upper end is 72 kN/m^2 and the discharge 0.0917 m^3/sec. Determine the pressure at the lower end in kN/m^2. Neglect friction losses. (10 marks)

QUESTION FOUR (20 MARKS)

a) Show that for a horizontal venturi meter with a U-tube mercury manometer, the actual discharge Q_A is given by:

$$Q_A = C_d a_1 \sqrt{\frac{2gx\left(\frac{\rho_m}{\rho_w}-1\right)}{m^2-1}}$$ (10 marks)

Where: C_d – coefficient of discharge

a_1 – cross section area of the pipe

x – mercury pressure head difference

ρ_m – mass density of mercury

ρ_w – mass density of water

m – cross section area of pipe / cross sectional area of throat

g – acceleration due to gravity

b) A horizontal venturi meter with a diameter of 200 mm at entry and 50 mm at the throat is used to measure the flow rate of water. The coefficient of discharge for the meter is 0.96. The difference in pressure between the entry and the throat is 30 kN/m^2. Calculate the discharge through the meter in m^3/sec. (10 marks)

QUESTION FIVE (20 MARKS)

a) Show that the discharge through a trapezoidal notch is given by;

$$Q = \frac{2}{3} C_d \sqrt{2g} H^{3/2} \left[B + \frac{4}{5} H \tan\theta\right]$$

Where: C_d – coefficient of discharge

g – acceleration due to gravity

H – depth of water in the notch

B – width of the notch

θ – angle sides of trapezoidal notch makes with the vertical (12 marks)

b) Calculate the value of the included angle for a V-notch which is to discharge 0.41 m^3/sec over a head of 0.6 m. Assume $C_d = 0.6$. (8 marks)