



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EEE 209: FLUID MECHANICS

DATE: _____

TIME: 2 HOURS

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) Concisely explain the meaning of the following terms;
- i) Compressibility (2 Marks)
 - ii) Vapour pressure (2 Marks)
- b) Show that water is practically incompressible compared to air (4 Marks)
- c) A hydraulic jack has a ram of 200 mm and a plunger of 20 mm diameter; both being at the same level. The plunger has a stroke of 0.30 m and makes 20 strokes per minute. The load to be lifted is 25 kN. Determine
- i) The force required to lift the load (2 Marks)
 - ii) The height through which the load is lifted per minute (2 Marks)
 - iii) The power required at the plunger (3 Marks)
- d) Fig. Q 1d) shows a U-tube manometer containing three liquids as indicated. Calculate the pressure ($P_A - P_B$) in kN/m^2 . (7 Marks)

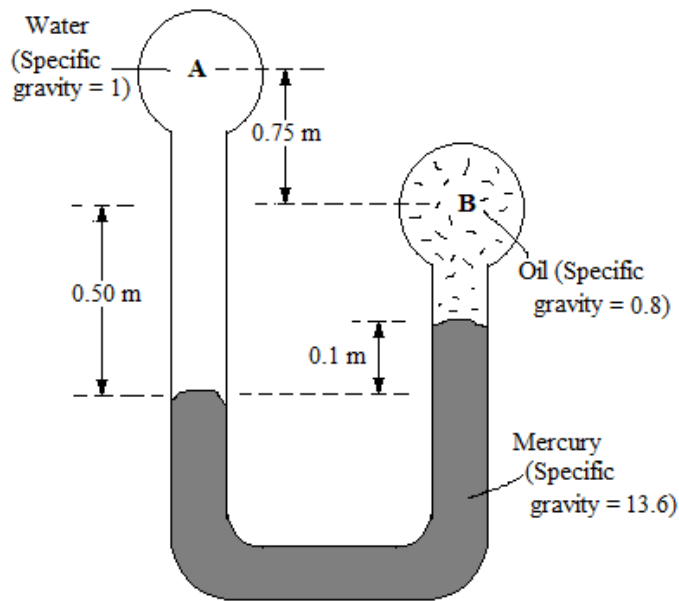


Fig. Q 1d)

- e) A 20 mm diameter pipe forms one branch 10 mm in diameter and the other 15 mm in diameter. If the velocity in the 10 mm diameter pipe is 0.3 m/s and that in the 15 mm diameter pipe is 0.8 m/s, calculate;
- The velocity of flow in the 20 mm channel pipe in m/s (4 marks)
 - The discharge in the 20 mm diameter pipe in m^3/s (4 marks)

QUESTION TWO (20 MARKS)

- Develop from first principles a general expression for the position of the centre of pressure on one side of a sloping flat plate completely immersed in the fluid in terms of the angle of inclination to the horizontal, the radius of gyration and the vertical depth of the centre of area of the plate below the free water level. (10 marks)
- A rectangular plate 2 m x 1 m is completely immersed in water while inclined at 60° to the water surface. The 1 m side is parallel to water surface. Determine the
 - Total force on surface in kN (3 marks)
 - Vertical depth of the centre of pressure below the surface (7 marks)

QUESTION THREE (20 MARKS)

- Working from first principles, explaining the meaning of the symbols used and stating the assumptions made, derive an expression for the theoretical discharge of water through an inclined venturi meter in terms of the cross-sectional area of the pipe, throat diameter and pressure head difference. (12 marks)

- b) The discharge in a 600 mm diameter horizontal water main is measured by means of a venturi meter with a throat diameter of 300 mm. The difference in pressure between the pipe and the throat corresponds to 250 mm of mercury. Determine the discharge in m^3/s ;
Assume: C_d for the meter = 0.99

Specific gravity of mercury = 13.6 (8 marks)

QUESTION FOUR (20 MARKS)

- a) Concisely describe an experimental determination of the coefficients of velocity, discharge and contraction of a small orifice at the side of a large reservoir (4 marks)
- b) What is the basic difference between a small and large orifice? (2 marks)
- c) Show that;
Coefficient of discharge = Coefficient of velocity $\times$ coefficient of contraction
for small orifices (2 marks)
- d) In order to determine the coefficient of velocity of a small circular sharp-edged orifice under low head, the..... measured when the head was 200 mm. the horizontal coordinate of a certain point of a jet from the vena contracta was found to be 812.5 mm while the vertical coordinate of the same point was 842.5 mm. Calculate the coefficient of velocity (3 marks)
- e) i) Using usual notations, explaining the meaning of all symbols used and stating the assumption made, derive an expression for discharge through a large orifice (5 marks)
- ii) A large rectangular orifice in the side of a large tank is 1.2 m broad and 0.6 m deep. The level of water in the tank is 0.6 m above the top edge of the orifice. Determine the discharge through the orifice. Assume $C_d = 0.62$ (4 marks)

QUESTION FIVE (20 MARKS)

- a) Discuss the classification of fluid machinery. (6 marks)
- b) Derive an expression for the theoretical hydraulic efficiency of a pelton wheel, using the usual notations, explaining the meaning of the symbols used and while working from first principles. (6 marks)
- c) A pelton wheel has a mean bucket speed of 12 m/s and is supplied with water at a rate of $0.6949 \text{ m}^3/\text{s}$ under a head of 30 m. The buckets deflect the jet through an angle of 160° . Calculate the
- i) the power developed (4 marks)
- ii) the hydraulic efficiency (4 marks)