MACHAKOS UNIVERSITY

University Examinations for 2022/2023 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATIONS FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 209: FLUID MECHANICS I

DATE: 13/4/2023 **TIME: 11:00 – 1:00 PM**

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) An observation point is 3 m vertically below the free surface of a liquid of relative density 1.53. Calculate the

i) Gauge pressure **(3 Marks)**

ii) Absolute pressure at the point in kN/m^3. **(4 Marks)**

Assume: Atmospheric pressure corresponds to 760 mm of mercury

Relative density of mercury = 13.6

Acceleration due to gravity = 9.81 m/s^2.

Mass density of water = 10^3 kg/m^3.

b) A u-tube manometer is used to measure the pressure difference between two points in a pipeline, as indicated in Fig. Q 1, conveying water. The specific gravity of the manometric liquid is 13.6. Point B is 0.325 m higher than point A, Calculate the pressure difference if h = 0.725 m. **(6 Marks)**

Figure 1

c) i) Distinguish between:

A. Impulse and reaction turbines **(2 Marks)**

B. Centre of pressure and centre of area **(2 Marks)**

ii) What is the basic difference between a turbine and a pump? **(2 Marks)**

d) State two factors which govern the stable floating of a body **(2 Marks)**

e) i) A cylindrical tank is spun with its axis vertical. Working from first principles, show that the water surface so generated is a paraboloid of revolution. **(5 Marks)**

ii) A cylindrical vessel of diameter 125 mm and height 0.325 m is rotated about a vertical axis. When at rest, water is poured to a depth of 75 mm. Calculate the speed of rotation in radians per sec at which the water will spill over the edge. **(4 Marks)**

QUESTION TWO (20 MARKS)

a) A circular laminar of radius r m is vertically submerged in water such that its top edge is tangetial to the water surface.

i) Derive an expression for the total force acting on one of its faces in terms of r, ρ and g. **(4 Marks)**

ii) Shoe that the vertical depth of its centre of pressure $\bar{h}$, is given by;

$\bar{h} = \frac{5r}{4}$ **(6 Marks)**

b) A circular laminar 1.4 m in diameter isn vertically submerged in water such that its top edge is tangetial to the water surface. Calculate the:

i) Total force acting on one side of the laminar **(4 Marks)**

ii) Vertical depth of the centre of pressure below the water surface. **(6 Marks)**

QUESTION THREE (20 MARKS)

a) Show that the discharge through an inclined venturi-meter is independent of inclination but depends on pressure head difference for the given meter. **(10 Marks)**

b) The flow rate in a pipeline 600 mm dimeter is measured by an inclined venturi meter with a 300 mm throat diameter. The pressure head difference corresponds to 200 mm of mercury and the coefficient of discharge is 0.97. Determine the discharge through the meter in m^3/sec. **(10 Marks)**

Assume the density of mercury = 13.6 x 10^3 kg/m^3.

QUESTION FOUR (20 MARKS)

a) Working from first principles and explaining the meaning of all the symbols used, derive an expression for hydraulic efficiency of a Pelton wheel in terms of absolute velocity of water from nozzle approaching the bucket, peripheral velocity of wheel and the angle through which water turns. (10 Marks)

b) A Pelton wheel with a peripheral wheel speed of 14.00 m/s has a discharge and head of 0.36 m^3/sec and 45 m respectively. The buckets deflect the jet through 160^0 degrees. Calculate the;

i) power output of the turbine in kW **(5 Marks)**

ii) hydraulic efficiency of this turbine. **(5 Marks)**

QUESTION FIVE (20 MARKS)

a) i) Show that for a large rectangular orifice, the actual discharge is given by;

$$Q = \frac{2}{3} C_d \sqrt{2g}\, B^{3/2}\left[{H_2}^{3/2} - {H_1}^{3/2}\right]$$

Where: C_d – coefficient of discharge

g – acceleration due to gravity

B – breadth of the orifice

H_2 – depth of the top edge below the free surface

H_1 – depth of the bottom edge below the free surface **(3 Marks)**

ii) In a large orifice, the top of the opening is 0.45 m below the water surface, the height is 1.45 m and width is 0.75 m. Calculate the discharge through the orifice in m^3/sec.

(4 Marks)

b) A. Define the following terms with respect to small orifices;

i) Coefficient of velocity **(1 Mark)**

ii) Coefficient of contraction **(1 Mark)**

iii) Coefficient of discharge. **(1 Mark)**

c) B. In order to determine the coefficient of velocity of a small circular sharp-edged orifice under low heads, the horizontal and vertical coordinates of the jet were measured when the head was 200 mm. The horizontal coordinate of a central point of the jet from vena contracta was found to be 812.5 mm while the vertical coordinate for the same point was 842.5 mm. Calculate the coefficient of velocity. **(5 Marks)**

d) Water is flowing down a vertical tapering pipe 3 m long. The top of the pipe has a diameter of 100 mm and the diameter of the bottom of the pipe is 50 mm. If the quantity of water flowing is 0.02273 m^3/sec, calculate the pressure difference between the top and bottom ends. **(5 Marks)**