MACHAKOS UNIVERSITY

University Supplementary Examinations 2023/2024

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

EMM 214: FLUID MECHANICS II

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) Describe the;

i) Physical structure **(5 Marks)**

ii) Mode of operation of aneroid barometer, using clearly labelled diagrams. **(5 Marks)**

b) i) Define the term "Energy Head" with specific reference to hygrograms. **(3 Marks)**

ii) A pipe line at an elevation 3 metres above the sea level conveys water at the velocity of 3.2 m/sec. The pressure of water in the pipe being 210 kN/m^2. Determine the total energy head of the water above the sea level. **(7 Marks)**

c) A hydraulic jack with the piston 0.3 metres vertically above the ram lifts a load of mass 1000 kg. The diameter of the ram is 125 mm. Determine the effort needed to lift the load if the diameter of the piston is 12.5 mm. **(7 Marks)**

d) Distinguish between the terms centre of pressure and centre of area. **(3 Marks)**

QUESTION TWO (20 MARKS)

A flat plate of breadth b and length d is vertically immersed in water such that the b dimension is tangential to the water surface.

a) i) Derive an expression for the vertical depth of the centre of pressure (h) below the free surface in terms of d. **(5 Marks)**

ii) the total force acting on the side of the plate in terms of mass density, acceleration due to gravity and the dimensions of the plate. **(4 Marks)**

b) The plate is 0.8 m wide and 1.5 m long.Working from first principles and exaplining the meaning of all symbols used, calculate the;

i) Total force acting on one side of the plate **(5 Marks)**

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

QUESTION THREE (20 MARKS)

a) Describe with the aid of clearly labelled diagrams, the;

i) Physical structure **(5 Marks)**

ii) Mode of operation of a pitot tube and a manometer suitable for use with such a tube when the difference of head is small. **(5 Marks)**

b) Discuss the relative advantages of using a venture meter rather than orifice meter to measure flow rates **(4 Marks)**

c) A pitot tube, Figure 1, inserted at the centre of 0.20 m dimameter pipe is connected to the wall static pressure tap through an inverted U-tube manometer.When the pipe conveys water, the u-tube shows a difference of 100 mm. Detemine the velocity of flow.

(6 Marks)

QUESTION FOUR (20 MARKS)

a) Water flows through a tapering pipe AB at the rate of 0.3 m^3/sec. The diameter at A is 0.45 m while at B is 0.15 m. Determine the rate of change of momentum between A and B.

(6 Marks)

b) A pipe conveying water tapers in cross-section of 0.618 m in dimeter at A to 0.437 m at B. At A, the mean velocity is 1.8 m/sec and the pressure is 1.17 x 10^5 N/m^2. Determine the pressure at B which is 6 m above the level at A. Assume that losses due to friction are small. **(14 Marks)**

QUESTION FIVE (20 MARKS)

a) i) Using usual notations, explaining the meaning of all symbols used while stating the assumptions made, derive an expression for discharge through a large rectangular orifice.

(3 Marks)

ii) A reservoir discharges through a large rectangular orifice. The top of the opening is 0.45 m below the water surface and the opening is 0.65 m wide and 1.6 m high. Calculate the theoretical discharge through the orifice in m^3/sec. **(3 Marks)**

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

i) Coefficient of contraction. **(1 Mark)**

ii) Coefficient of velocity. **(1 Mark)**

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

c) Concisely describe experimental determination of the coefficient of contraction, velocity and discharge of a small orifice. **(3 Marks)**

d) A jet of water discharges horizontally into the atmosphere from a small orifice in the side of a large reservoir. Derive an expression for the;

i) Actual velocity of the jet at the vena contracta if the jet falls a distance of vertical and horizontal distance x measured from the vena contracta. **(2 Marks)**

ii) If the head of water is H, calculate the coefficient of velocity **(2 Marks)**

e) 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 was 812.5 mm while the vertical was 842.5 m. Determine the coefficient of velocity. **(4 Marks)**