MACHAKOS UNIVERSITY

University Examinations for 2019/2020Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

EEE 209 FLUID MECHANICS

DATE: 10/12/2020 **TIME: 8:30 – 10:30 AM**

INSTRUCTIONS

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

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Explain the meaning of the following terms

i. Atmospheric pressure (1 mark)

ii. Gauge pressure (2 marks)

iii. Absolute pressure (2 marks)

b) Using clearly labelled diagrams, describe the structure and explain the mode of operation of the following:

i. Barometric pressure gauge (4 marks)

ii. Bourdon pressure gauge (5 marks)

c) In Fig 1 fluid A is oil of specific gravity 0.85 and fluid b is water. If a is 0.12m, b is 0.6m, calculate the pressure difference between M and N is KN/m^2. (4 marks)

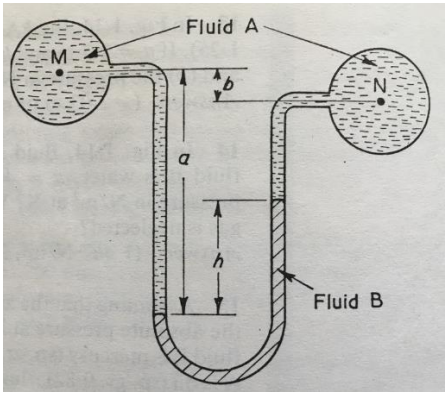


Fig 1.

d) i State Pascal's Law (2 marks)

ii Show that pressure at a point in a fluid at rest is equal in all directions. (4 marks)

iii A hydraulic press has a ram diameter of 125mm, what force would be required on the plunger to lift a load of 1kN on the ram if the plunger diameter is 25mm. (2 marks)

i. If the plunger had a stroke of 250mm, how many strokes would raise the load to a height of 0.3m? (2 marks)

e) Water is at a depth of 12m below the free atmospheric surface.

Calculate the:

i. Gauge pressure of water in N/m^2 (1 mark)

ii. Absolute pressure of water in N/m^2 (1 mark)

Assume: density of water = 10^3 kg/m^3

Atmospheric pressure is 760mm of mercury

Relative density of mercury = 13.6

QUESTION TWO (20 MARKS)

a) A plane flat surface is vertically completely immersed in water so that its centre of area is $\bar{y}$ metres vertically below the free surface.

Working from first principles, stating all the assumptions and explaining the meaning of all symbols used, show that the vertical depth of the centre of pressure below the free surface $\hbar$ Is given by $\hbar = \frac{k^2}{\bar{y}} + \bar{y}$

where k is the radius of gyration of the surface. (10 marks)

b) A rectangular plate of breadth 0.5m is vertically immersed in water so that its centre of area is 1.1m vertically below the free surface and the centre of pressure is 1.176m below the free surface.

Calculate the:

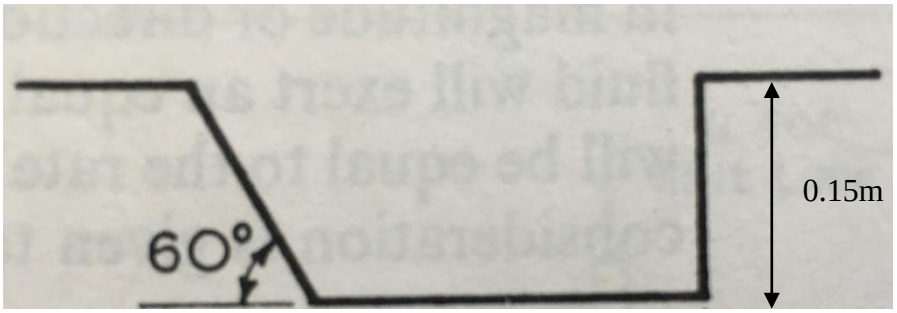
i. Height of the plate in metres (6 marks)

ii. Total force acting one side of the plate (4 marks)

QUESTION THREE (20 MARKS)

a) A trapezoid notch has a base width L and each side makes an angle θ to the vertical. The depth of the water in the notch is H. Derive an expression, working from first principles for the theoretical discharge through the notch. (10 marks)

b) The theoretical discharge through the notch shown in Fig 2 is 0.0403 m^3/sec. Calculate its base width if the depth of water above the sill is 0.15m. (10 marks)



QUESTION FOUR (20 MARKS)

a) Derive the Bernoulli's equation for an incompressible frictionless fluid from momentum consideration. (10 marks)

b) Water is pumped up from a level A to level B through a vertical height of 11m through a pipe tapering in diameter from 100mm at A to 150mm at B. The pressure head at A is 24m of water and at B is 13.5m.

Calculate the discharge through the pipe in m^3/sec. (10 marks)

QUESTION FIVE (20 MARKS)

a) Distinguish impulse turbines from reaction turbines. (4 marks)

b) Show that in a venturimeter, the quantity of water passing through the meter will only be proportional to the root of the "venturi head" assuming the flow is incompressible and frictionless. (8 marks)

c) The flow rate through a 600mm diameter horizontal water main is measured by means of a venturimeter with a throat diameter of 300mm. The difference in pressure between the pipe and the throat corresponds to 250mm of mercury. The actual discharge is 0.59 m^3/sec. Calculate the coefficient of discharge for the meter. (8 marks)