MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SPECIAL/SUPPLIMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 209 FLUID MECHANICS

DATE: 24/3/2021 **TIME: 8.30-10.30 AM**

INSTRUCTIONS

This paper contains five questions
Question ONE is Compulsory and carries 30 marks
Four remaining questions carry 20 marks each
Attempt question one and any other two questions

QUESTION ONE (COMPULSORY) (30 MARKS)

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

b) A U- tube mercury manometer is used to measure the absolute pressure of water at A as indicated in figure 1

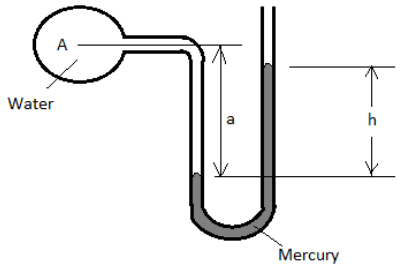

Figure 1

Calculate the absolute pressure at A when a =1.5m , h =1.16m

Assume specific density of Mercury is 1.36 (4 marks)

c) i) Using usual notations and explaining the meaning of all symbols used show that when a cylindrical vessel containing water is spun in a vertical plane, the water surface will form a paraboloid of revolution. (4 marks)

ii) A cylindrical vessel 100mm in diameter and 0.3 m high contains water when at rest to a depth of 225 mm . If the vessel is rotated abound its longitudinal axis which is vertical, calculate;

- speed at which water will start to spill over the edge. (4 marks)
- the axial depth (2 marks)

d) i) State the three conditions in which a solid body can be at equilibrium. (3 marks)

ii) Define the term 'metacenter' (2 marks)

iii) Show how stability of a floating body depends on the position of the metacenter and the centre of gravity (3 marks)

iv) A one cubic meter of ice floats freely in a vessel at 0^0 C. How much of the ice is exposed? (2 marks)

v) What will be the change of the level of water when the ice melts (assume the area of the water surface is $4m^2$). (1 mark)

QUESTION TWO (20MARKS)

a) Show that for a completely submerged flat plate inclined at Θ degrees to the horizontal the depth of the center of pressure $\hbar$ vertically below the surface is given by

$\hbar = I_B \, Sin^2\Theta$

$$\hbar = \frac{I_B Sin^2\theta}{A\breve{y}}$$

Where $\breve{y}$ = the depth of the center of area vertically below the free surface

A = surface area of the submerged surface

I_B = 2^{nd} moment of area of the surface about B (8 marks)

b) A circular plane plate of 4m diameter is immersed in water with its plane making an angle of 30^0 with water surface and the top edge touching the water surface also.

Calculate the:-

i. Depth of the center of pressure vertically below the free surface. (8 marks)

ii. The total force acting on the surface (6 marks)

Assume the density of water is 10^3 kg/m^3 and g = 9.81 m/sec^2

QUESTION THREE (20 MARKS)

a) Define the term 'continuity" (2 marks)

b) Two points A and B in a pipe line are 24m and 12m respectively above datum level. The diameter of the pipe at A is 150 mm while at B is 100 mm diameter, the pressure at A is 82 KN/m^2 and 1350 dm^3 of water per minute flow from A to B .

Determine the :-

i. total energy per kg of water at A with reference in datum level (8 marks)

ii. pressure at B assuming that the loss of head due to friction between A and B is 3m (10 marks)

QUESTION FOUR (20 MARKS)

a) Using usual notations and explain the meaning of all symbols used, derive an expression for the discharge through a horizontal venturimeter for an incompressible frictionless fluid. (10 marks)

b) A venturimeter fitted to a pipe 450mm diameter has a throat diameter 200mm. Calculate the flow rate through the venturimeter when the venturi head is 175 mm of water.

Assume Cd is 0.96 (10 marks)

QUESTION FIVE (20 MARKS)

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

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

Where Cd=coefficient of discharge

L=Width of the rectangular section of the trapezium

θ=inclination of the side of the trapezium to the vertical

H=depth of water below the free surface (12 marks)

b) Calculate the quantity of water flowing over a V-notch having an included angle of 90^0 which when the head is 0.2 meters

Assume the coefficient of discharge is = 0.6 (8 marks)