MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 209: FLUID MECHANICS

DATE: 15/6/2017 **TIME: 11:00 – 1:00 PM**

INSTRUCTIONS

Answer all questions in Section A and choose any other TWO in Section B

SECTION A: (COMPULSORY)

QUESTION ONE (30 MARKS)

a) Define the following terms

i. Absolute pressure

ii. Kinematic viscosity

iii. A piezometer

iv. Fluidity (2 marks each)

b) i. Show that the pressure at a point in a liquid at rest is equal or the same in all directions. (5 marks)

ii. Two cylinders with pistons are connected by a rigid tube containing water. Their diameters are 75mm and 750mm respectively. The face of the smaller piston is 6.5m higher than that of the larger one. The load on the larger cylinder is 600kg. Calculate the force needed on the smaller cylinder to maintain this load? (6 marks)

c) Reference is made to Figure 2, fluid A is oil of specific gravity 0.9 and fluid B is water. If h= 1.25m b= 0.625m and h=0.5 m. Calculate the difference in pressure, measured in KN/m^2 between M and N (5 marks)

d) A container partially filled with a liquid and moving horizontally with a constant linear acceleration has its liquid surface inclined at 30^0c to the horizontal. Calculate its acceleration (4 marks)

e) State the two conditions necessary to ensure the stable equilibrium of a body partly immersed in a liquid. (2 marks)

QUESTION TWO (20 MARKS)

a) Derive the Bernoulli's Equation for an incompressible frictionless fluid from momentum consideration (6 marks)

b) Define the term continuity with respect to incompressible flow (2 marks)

c) Oil flows through a pipeline (see figure 1) which tapers from 450mm diameter at A to 300mm diameter at B, and then forks; one branch being 150mm in diameter discharging at C and the other branch 225 mm diameter discharging at D. The velocity at A is 1.8m/sec and the velocity at D=3.6m/sec. Calculate the;

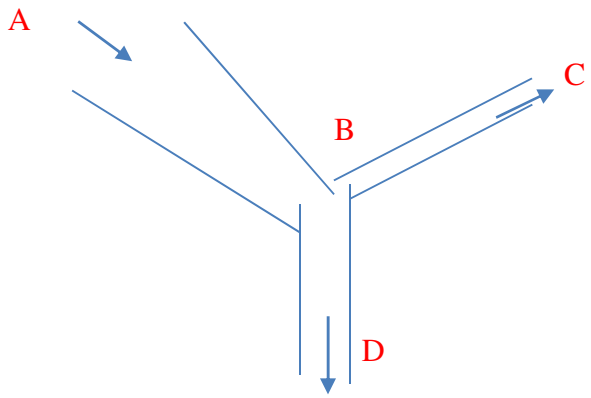
i. Discharge at C in m^3/sec (3 marks)

ii. Discharge at D in m^3/sec (3 marks)

iii. Velocity at B in m^3/sec (3 marks)

iv. Velocity at C in m^3/sec (3 marks)

Fig 1.



QUESTION THREE (20MARKS)

a) Show that for a plane surface completely immersed in water and inclined at **ɵ** to horizontal, the depth of the centre of pressure $\hat{\mathbf{h}}$ below the free surface is given by

$$\hat{h} = \frac{\sin^2 \theta I_{oo}}{A\acute{y}}$$

where $\mathbf{I_{00}}$ = the 2nd moment of area of the surface about the line of intersection of the free water surface and the immersed surface.

θ = the angle of inclination of the immersed surface to the horizontal

A = area of the surface

ý = the depth of the centre of area below the free water surface

b) Fig 3 represents a trap door, 3m wide and 2.4 m long in the side of a water tank. It is pivoted at Q and held against water pressure by eight bolts at R. calculate the force in each bolt. Assume; the water level is 1.8m vertically above R,

The density of water = 103 kg/m^3,

Acceleration due to gravity = 9.81m/s^2 (10 marks)

QUESTION FOUR (20 MARKS)

a) Show that for a small orifice at the side of a large tank containing water,

$C_d = C_v \times C_c$

Where C_d = coefficient of discharge

C_v = coefficient of velocity

C_c = coefficient of contraction (3 marks)

b) In an experiment on an orifice, the following results were obtained:

Orifice diameter = 6.5mm

Discharge of water = 23.4 kg in 4mins

Fall of jet 300mm in horizontal distance of 1.175m

Head of water above the centerline of the orifice 1.2m

Calculate the coefficients of;

i. Discharge (2 marks)

ii. Velocity (2 marks)

iii. Contraction (2 marks)

c) Using usual notation, explaining the meaning of all symbols used, and stating assumptions made, derive the expression for the theoretical discharge through a horizontal venturi-meter (2 marks)

d) The flow in a 600mm diameter horizontal water main is measured by means of a venture meter with a throat diameter of 300mm. the difference in pressure between the pipe and the throat corresponds to 250mm of mercury. Calculate the flow rate in m3/sec.
Assume C_d for the metre = 0.99
The relative density of mercury = 13.6 (6 marks)

QUESTION FIVE (20 MARKS)

a) A trapezoidal notch has a base of width L and each side makes an angle of θ^0 to the vertical. Working from the first principles derive an expression for the discharge through the notch. (12 marks)

b) The discharge through a right-angled V-notch is given by $Q = KH^{\frac{5}{2}}$, H measured in meters is the height of water surface above the bottom of the notch and K is a constant. What is the value of K? (4 marks)

c) Distinguish between impulse and reaction turbines (4 marks)