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CSE 251

(*University of Choice*)

# MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

**MAIN CAMPUS**

## UNIVERSITY SPECIAL/SUPLEMENTARY EXAMINATIONS 2021/2022 ACADEMIC YEAR

## SECOND YEAR FIRST SEMESTER EXAMINATIONS

## FOR THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL AND STRUCTURAL ENGINEERING

**COURSE CODE: CSE 251/TEB 351**

**COURSE TITLE: FLUID MECHANICS I**

**DATE: 29TH JULY 2022** **TIME: 3P.M – 5 P.M**

**Instructions to candidates**

- This paper consists of **FIVE** questions.
- Answer question **ONE** and **ANY** other **THREE** questions
- All symbols have their usual meaning unless otherwise stated
- Time allowed is **TWO (2)** hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over.

**Question ONE {Compulsory (25 marks)}**

a) Calculate the density, specific weight and weight of one litre of petrol of specific gravity of 0.7 (3 marks)

b) State THREE merits and THREE demerits of use of manometers as devices for measuring pressure at a point in a fluid (3 marks)

c) The following cases represent the two velocity components; determine the third component of velocity such that they satisfy the continuity equation. (5 marks)

$$u = x^2 + y^2 + z^2; \quad v = xy^2 - yz^2 + xy$$

d) Determine the total pressure and the centre of pressure on one side of an immersed rectangular plate, 1.8m long and 0.9m wide, when the plate makes an angle of $60^0$ with the surface of water. The 0.9m edge is parallel to, and at a depth of 0.75m below the surface level of water as shown in Figure 1(d) below (6 marks)

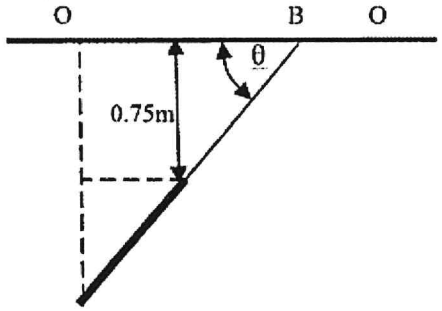


Figure 1(d)

e) The characteristics of a spillway are to be studied by means of geometrically similar model constructed to the scale of 1:10

i. If the maximum rate of flow in the prototype is $28.3m^3/s$, what will be the corresponding flow in the model? (2 marks)

ii. If the measured velocity in the model at a point on the spillway is 2.4 m/s, what will be the corresponding velocity in prototype? (2 marks)

iii. If the hydraulic jump at the foot of the model is 50mm high, what will be the height of jump in prototype? (2 marks)

iv. If the energy dissipated per second in the model is 3.5 Nm, what energy is dissipated per second in the prototype? (2 marks)

**Question TWO (15 marks)**

a) Calculate the dynamic viscosity of oil, which is used for lubrication between a square plate of side 0.8m and an incline plane with angle of inclination of 30° as shown in Figure 2(a) below. The weight of the square plate is 300 N and it slides down the inclined plane with a uniform velocity of 0.3 m/s. The thickness of the oil film is 1.5mm. (5 marks)

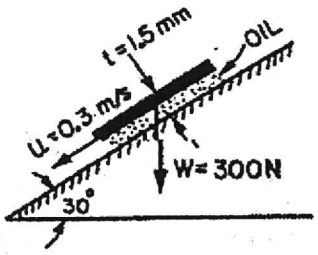


Figure 2(a)

b) Using Buckingham's $\pi$ Theorem, show that the velocity through a circular orifice is given by:

$$V = \sqrt{2gH}\ \emptyset \begin{bmatrix} D & \mu \\ H' & \rho VH \end{bmatrix}$$

Where $H$ is the head causing flow, $D$ is the diameter of orifice, $\mu$ is the coefficient of viscosity, $\rho$ is the mass density and $g$ is the acceleration due to gravity (10 marks)

**Question THREE (15 marks)**

a) An inverted U-tube manometer is connected to two horizontal pipes A and B through which water is flowing as shown in Figure 3(a) below. Oil of specific gravity of 0.8 is used as gauge fluid. Determine the difference of pressure between the pipes (6 marks)

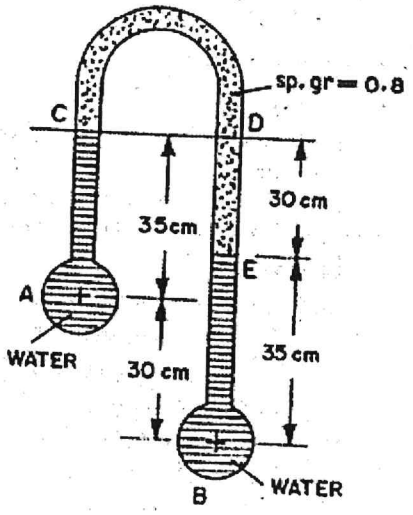


Figure 3(a)

b) The ratio of lengths of sub-marine and its model is 30:1. The speed of sub-marine (prototype) is 10 m/s. The model is to be tested in a wind tunnel. Find the speed of air in wind tunnel. Also determine the ratio of drag (resistance) between the model and its prototype. Take the value of kinematic viscosities for sea water and air as $1.2 \times 10^{-2}$ cm$^2$/s and $1.6 \times 10^{-2}$ cm$^2$/s respectively. The density for sea water and air is given as 1030 kg/m$^3$ and 1.24 kg/m$^3$ respectively (9 marks)

**Question FOUR (15 marks)**

a) Given that the Manning formula for velocity under MKS system is given by:

$$V = MR^{\frac{2}{3}} S^{\frac{1}{2}}$$

Where $V$ is the velocity of flow, $R$ is the hydraulic radius, $S$ is the channel slope and $M$ is manning coefficient. Determine the Manning formula under FPS system (3 marks)

b) Distinguish the following types of flow in fluids
   i. Steady flow
   ii. Uniform flow
   iii. Laminar flow
   iv. Compressible flow (4 marks)

c) A block of wood measuring 2m x 1m x 0.8m and of specific gravity of 0.7 floats in water as shown in Figure 4(c) below. Determine the meta-centre of the block. (8 marks)

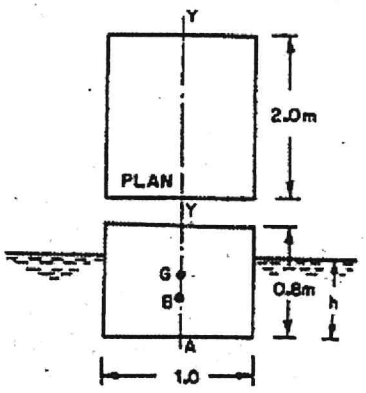


Figure 4(c)

**Question FIVE (15 marks)**

a) Calculate the capillary rise in a glass tube of 2.5mm diameter when immersed vertically in (i) water and (ii) in mercury. Take surface tensions of water and mercury as 0.0725 and 0.52 N/m in contact with air respectively. The specific gravity of mercury is 13.6 and angle of contact is 130°. Comment on your answers (4 marks)

b) Briefly explain the types of fluids based on viscosity (5 marks)

c) The discharge through a weir is $1.5m^3/s$. Find the discharge through the model of the weir if the horizontal dimension of the model is 1:50 the horizontal dimension of the prototype and vertical dimension of the model is 1:10 the vertical dimension of the prototype.(6 marks)