MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 204: FLUID MECHANICS 1

DATE: 12/8/2021 **TIME: 2.00-4.00 PM**

INSTRUCTIONS

This paper contains Five (5) question

Answer question ONE (compulsory) and any other two questions.

All symbols have their usual meaning.

QUESTION ONE (30 MARKS)

a) Define the following terms as used in fluid mechanics (3 marks)

i. Weight density

ii. Specific gravity

iii. Mass density

b) i. Explain why the viscosity of liquids decreases with increase in temperature, while for gases the viscosity increases with increase in temperature? (4 marks)

ii. Calculate the dynamics viscosity of an oil, which is used for lubrication purposes between a square plate of size 0.8 m x 0.8 m and an inclination plane with angle of inclination of 30^{o} as shown in Fig. Q1 b (ii). 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 oil film is 1.5 mm (5 marks)

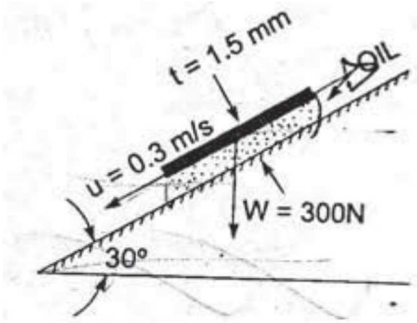

Fig. Q 1 b (ii)

c) Show that the expression for capillary fall for a glass dipped in mercury is given by;

$$h = \frac{4\sigma\, cos\theta}{\rho g d}$$

where; σ is the surface tension, θ, is the angle between the liquid and glass tube, *d,* is the diameter of glass tube, ρ, is the density and *g,* is the acceleration due to gravity. (5 marks)

d) A Mechanical engineering student at Machakos University conducting an experiment inserted the same glass tube of 2.5 mm diameter in a vessel containing water, then in another vessel containing mercury. The surface tension of water was determined as 0.0725 N/m while for mercury was 0.52 N/m. The specific gravity of mercury is given as 13.6 and the angle of contact as 130^o. Determine the capillary rise for each case. (3 marks)

e) Differentiate between the following terms

i. buoyancy and center of buoyancy (2 marks)

ii. Meta center and mate center height (2 marks)

f) Find the volume of the water displaced and position of center of buoyancy for a wooden block of width 2.5 m and depth 1.5m when it floats horizontally in water. The density of wooden block is 650kg/m^3 and its length is 6m. (6 marks)

QUESTION TWO (20 MARKS)

a) Differentiate between gauge pressure and vacuum pressure. (2 marks)

b) Show that the pressure (*p*) measured in a pipe using an inclined single column manometer can be expressed as;

$$p = L \sin\theta \text{ x } \rho_2 g - h_1 \rho_1 g$$

where; h_1 is the height of center of pipe above datum level, ρ_1 is the density of liquid in a pipe, ρ_2 is the density of liquid in reservoir, *L* is the length of liquid moved above datum level and, θ is the inclination of right limb with horizontal. (12 marks)

c) A single column manometer is connected to a pipe containing a liquid of specific gravity 0.9 as shown in Fig. Q2 (c). Find the pressure in the pipe if the area of the reservoir is 100 times the area of the tube. The specific gravity of mercury is 13.6 (4 marks)

d) Using sketches differentiate between U – tube manometer for measuring; (2 marks)

i. Pressure in two pipes at different levels

ii. Pressure in two pipes at the same level

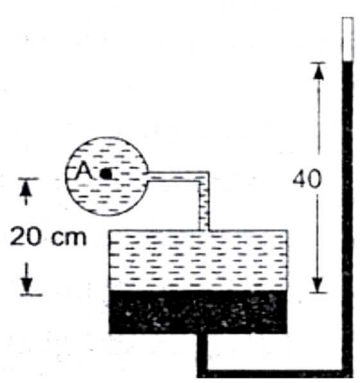

Fig. Q2 (c)

QUESTION THREE (20 MARKS)

a) Differentiate between total pressure and center of pressure. (2 marks)

b) A pipe line which is 4 m in diameter contains a gate valve. The pressure at the center of the pipe is 19.6 N/cm^2. If the pipe is filled with oil of specific gravity 0.87. Find the force exerted by the oil upon the gate and position of center of pressure. (6 marks)

c) A rectangular gate 5 m x 2 m is hinged at its base and inclined at 60^o to the horizontal as shown in Fig. Q 3 (c). To keep the gate in a stable position, a counter weight of 5000 kgf (49050 N) is attached at the upper end of the gate as shown in Fig. Q3 (c). Find the depth of water at which the gate begins to fall. Neglect the weight of the gate and friction at the hinge and pulley. (12 marks)

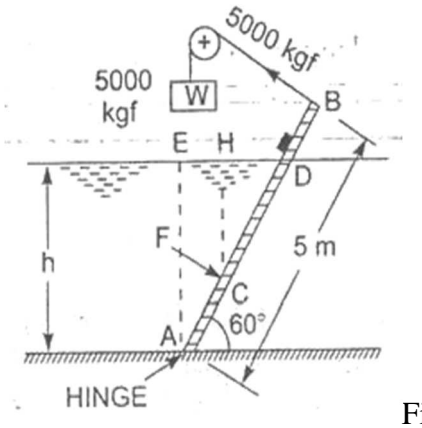

Fig. Q 3 (c)

QUESTION FOUR (20 MARKS)

a) i. Show that Euler's equation of motion is gives as; (11.5 marks)

$$\frac{\partial p}{\rho} + gdz + vdv = 0$$

Where the symbols have their usual meaning

ii. State the assumption made in derivation of Bernoulli's equation. (2 marks)

b) Water is flowing through a pipe having diameter of 300 mm and 200 mm at the bottom and upper end respectively. The intensity of pressure at the bottom end is 24.525 N/cm^2 and the pressure at the upper end is 9.81 N/cm^2. Determine the difference in datum head if the rate of flow through pipe is 40 liters/second. (6.5 marks)

QUESTION FIVE (20 MARKS)

a) i. Show that the theoretical discharge (Q_{Th}) through a venturimeter is expressed as;

$$Q_{Th} = \frac{a_1 a_2}{\sqrt{a_1{}^2 - a_2{}^2}} \times \sqrt{2gh}$$

Where; h, is the difference in pressure head and a, is the area of the section. (9.5 marks)

ii. A horizontal venturimeter with inlet and throat diameter of 30 cm and 15 cm respectively is used to measure the flow of water. The reading of differential manometer connected to the inlet and the throat is 20 cm of mercury. Determine the rate of flow. Take $c_d = 0.98$. (6.5 marks)

b) Differentiate between;

i. Steady and unsteady flow (2 marks)

ii. Uniform and non-uniform flow (2 marks)