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 (MECHANICAL ENGINEERING)

EMM 204: FLUID MECHANICS 1

DATE: 23/3/2021 **TIME: 2.00-4.00 PM**

INSTRUCTIONS

This paper contains FIVE questions
Question ONE is **compulsory** and carries 30 Marks
Questions TWO – FIVE carries 20 Marks each. **Answer any Two**

QUESTIONS ONE (30 MARKS)

a) What is a fluid? (2 marks)

b) Name the fundamental principles of mechanics that are applied to liquids and gasses (3 marks)

c) Discuss FOUR distinctive properties of fluids (8 marks)

d) The intensity of pressure at a point in a fluid at rest is usually the same in all directions. Is it true or false? Prove your answer (6 marks)

e) Define the term surface tension? (2 marks)

f) Distinguish between:

i. Laminar and turbulent flow (2 marks)

ii. Steady and non-steady flow (2 marks)

g) Calculate the Reynolds number for a fluid of density 800 kg/m^3 and dynamic viscosity 1.02 x 10^{-3} kg/m.s flowing in a 3 mm diameter pipe at 2.5 m/s. Determine whether the flow is laminar or turbulent. (3 marks)

h) Differentiate between absolute and gauge pressure (2 marks)

QUESTIONS TWO (20 MARKS)

a) Water flows in a horizontal pipeline and gradually converges from diameter of 200 mm at a position A to a diameter of 100 mm at position B. if the velocity is 2 m/s and the pressure head at A is 15 m, calculate the pressure at section A, velocity and pressure at B (8 marks)

b) Consider a plane surface, immersed in a liquid whose free surface is indicated as OO as shown in Figure Q2b. Derive formulae for determination of the intensity of pressure (Total pressure) and the position of centre of pressure for the figure (12 marks)

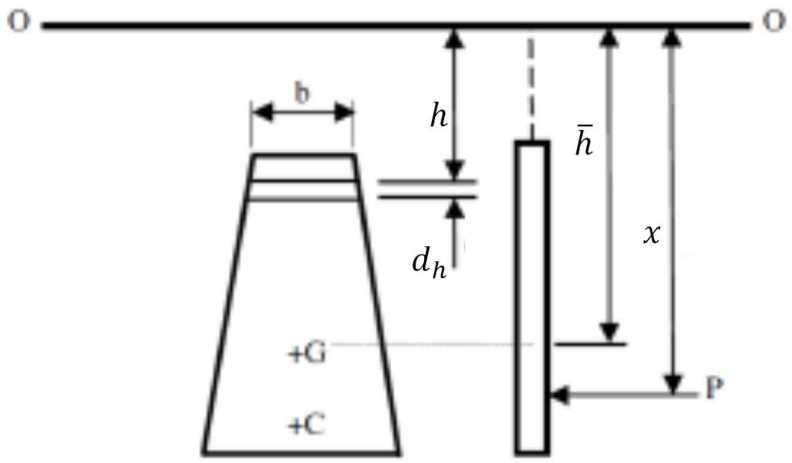

Figure Q2b

QUESTIONS THREE (20 MARKS)

a) Define the term Metacentre and show using diagrams how the stability of a floating body depends upon the position of the Metacentre and the centre of gravity (10 marks)

b) A rectangular pontoon has a width of 7.0 m, a length of 13.0 m, and depth of 1.4 m in fresh water of density 1000 kg/m^3. Calculate:

i. Weight of the pontoon (3 marks)

ii. Its depth in sea water of density 1024 kg/m^3 (3 marks)

iii. The load that can be supported by the pontoon in fresh water if the maximum depth permissible is 1.5 m (4 marks)

QUESTIONS FOUR (20 MARKS)

a) (i) Derive an expression for the flow measurement in an open channel using rectangular notch and show that the total discharge, Q can be given by

$$Q = \frac{2}{3} C_d B \sqrt{2g} H^{\frac{3}{2}}$$

Where, C_d is the coefficient of discharge and g is the force of gravity. Consider Figure Q4a (6 marks)

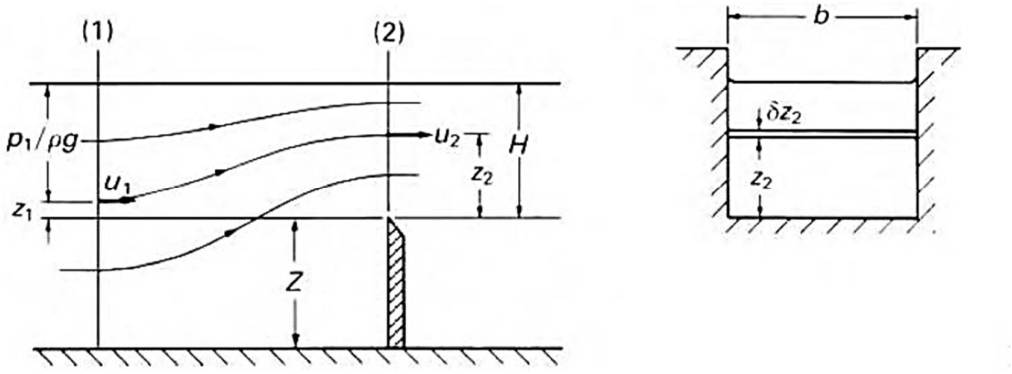

Figure 4a

(ii) State four assumptions made in the derivation of the equation in (i) above (2 marks)

(iii) A Weir of 8.4 m long is to be built across a rectangular channel to discharge a flow of 9.5 m^3 /s. If the maximum depth of water on the upstream side of weir is to be 3 m, what should be the height of the weir? Adopt $C_d = 0.62$ (3 marks)

b) Figure 3Qb shows an inverted U-tube manometer connected to two pipes A and B which convey water. The fluid in the manometer is oil of specific gravity 0.8. Determine the pressure difference between pipes A and B. (3 marks)

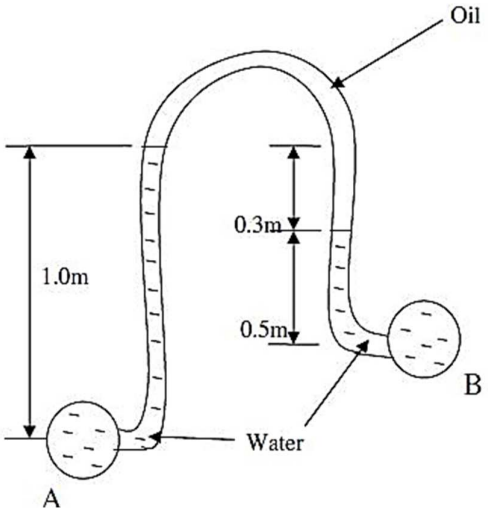

Figure Q3b

c) Two plates are placed at a distance of 0.14 mm apart. The lower plate is fixed while the upper plate having surface area 1.2 m^2 is pulled at 0.25 m/s. Find the force and power required to maintain this speed if the fluid separating them is of viscosity 0.15 NS/m^2 (6 marks)

QUESTION FIVE (20 MARKS)

a) Describe the following devices used in fluid mechanics and state one application for each

i. Pitot-static tube (2 marks)

ii. Orifice (2 marks)

b) Come up with the expression for rate of flow through a venture-meter (5 marks)

c) Water flows through a pipe having diameters of 32 cm and 22 cm respectively. The intensity of pressure at the bottom end is 26×10^4 N/m^2 and the upper end is 9.81×10^4 N/m^2. Determine the differences in datum head if the discharge through the pipe is 40 l/sec (5 marks)

d) Discuss the effects of temperature on the viscosity of liquids and gases (4 marks)

e) Define capillarity as used in fluid mechanics (2 marks)