JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

UNIVERSITY EXAMIMATION FOR THE DEGREE IN SCIENCE IN RENEWABLE ENERGY TECHNOLOGY AND MANAGEMENT

2ND YEAR 1ST SEMESTER 2023/2024 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: TEB 1205

COURSE TITLE: FLUID MECHANICS I

EXAM VENUE: **STREAM: BSc. REN ENGY TEC & MGT**

DATE: /12/2023 **EXAM SESSION:**

DURATION: 2 HOURS

Instructions

1. **Answer question 1 (Compulsory) and ANY other two questions**
2. **Candidates are advised not to write on question paper**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

QUESTION 1 (30 MARKS)

a. Briefly explain the following terms/expressions as applied in fluid mechanics. Use mathematical expressions where possible.

i. Steady flow **(3 marks)**

ii. Surface tension **(3 Marks)**

iii. Newton's Law of Viscosity **(3 Marks)**

b. Verify Pascal's principle by showing that pressure at a point in a fluid at rest is the same in all directions. **(6 Marks)**

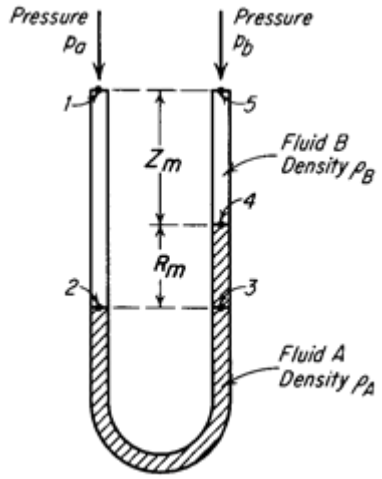
c. Explain the following principles and their importance in fluid mechanics (use mathematical expressions where applicable);

i. Parallel axis theorem **(3 Marks)**

ii. Mass conservation **(3 Marks)**

iii. Conservation of energy **(3 Marks)**

d. Apply the basic equation of static fluids to both legs of manometer, and show that; $P_a - P_b = gR_m(\rho_a - \rho_b)$ **(6 Marks)**



QUESTION 2 (20 MARKS)

a. Illustrate how liquids comes into "relative equilibrium" when the vessel containing the liquid is subjected to a constant linear horizontal acceleration. **(6 Marks)**

b. Differentiate between the centre of buoyancy and the centre of gravity of a floating body. **(6 Marks)**

c. Define the term "metacentre" and show how stability of a floating body depends upon the position of the metacentre and the centre of gravity. Use sketches where appropriate. **(8 Marks)**

QUESTION 3 (20 MARKS)

a. For a plane surface of area A, inclined to the horizontal at an angle θ in a fluid of uniform density ρ. Show that the vertical depth of the centre of force, h_C, is given by;

$$h_C = \bar{h} + \frac{I_G Sin^2\theta}{A\bar{h}},$$

Where; $\bar{h}$ is the vertical depth of the centroid, θ is the plane angle of inclination with fluid surface. A is the area of the horizontal, I_G is the second moment of area about the centre of the centroid. (Mention any assumptions made). **(12 Marks)**

b. A tank contains water of density 1000kg/m3 upto a height of 3m above the base. An immiscible liquid of specific gravity 0.8 is filled on top of that over 2m depth. Calculate the pressures at a point 1.5m below the free surface, at the interface and at another point 2.5m below the free surface. Calculate also the force on a vertical wall, 6m wide.

(8 Marks)

QUESTION 4 (20 MARKS)

a. Show that the hydrostatic thrust *F*, on a vertical rectangular plane surface with its upper edge in the free surface of a fluid is given by; $F = \frac{\rho g b d^2}{2}$; and acts at two thirds its length *d*;

Where ρ is the fluid density, *d* is the length of the rectangle measured vertically from the fluid surface, *b* is the width of the rectangle and *g* is the gravitational acceleration.

(12 Marks)

b. A steel pipeline conveying gas has an internal diameter of 120cm and an external diameter of 125cm. It is laid across the bed of a river, completely immersed in water and is anchored at intervals of 4m along its length. Calculate the buoyancy force in Newtons per metre run and the upward force in newtons on each anchorage. Density of steel =7900kg/m3, density of water 1000kg/m3. **(8 Marks)**

QUESTION 5 (20 MARKS)

From the first principles, derive Euler's equation and show how it degenerates into Bernoulli's equation. State any assumptions and define all terms used in each equation.

(20 Marks)