JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

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

2ND YEAR 1ST SEMESTER 2024/2025 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: TEB 1205

COURSE TITLE: FLUID MECHANICS I

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

DATE: 13 /1/2025 **EXAM SESSION:9-11.00 AM**

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.**

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QUESTION ONE (30 MARKS)

a. Explain the following terms used in fluid mechanics showing mathematical expressions;

   i. Parallel axis theorem

   ii. Conservation of mass

   iii. Conservation of energy

   iv. Capillarity **(12 Marks)**

b. Explain the application of Pascal's principle in fluid mechanics and show that pressure at a point in a fluid at rest is the same in all directions. **(8 Marks)**

c. Explain what you understand by "hydrostatic force", hence show that the hydrostatic thrust F, on a

d. vertical rectangular plane surface with its upper edge in the free surface of a fluid is given by; $F = \frac{\rho g b d^2}{2}$; 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. **(10 Marks)**

QUESTION TWO (20 MARKS)

a. Briefly discuss the difference and importance of the "centre of buoyancy" and the "centre of gravity" of a floating body. **(10 Marks)**

b. With respect to floating bodies, explain the relationship between stability and metacenter. Use sketches where necessary.

(10 Marks)

QUESTION THREE (20 MARKS)

a. Describe the following terms as used in fluid mechanics. **(6 Marks)**

   i. Viscosity
   ii. Surface tension

b. Describe the possible conditions in which a solid body can be in equilibrium. Use sketches where appropriate. **(6 Marks)**

c. The degree to which a fluid offers resistance to compression is expressed by its bulk modulus of elasticity, K. Show that; $K = \rho \frac{dp}{d\rho}$; where dp is change in pressure, ρ is density and $d\rho$ is change in density.

(8 Marks)

QUESTION FOUR (20 MARKS)

a. A manometer is fitted as shown in the figure 1 below. Determine the pressure at point A. With respect to datum at B, pressure at left hand side = pressure at right hand side. **(8 Marks)**

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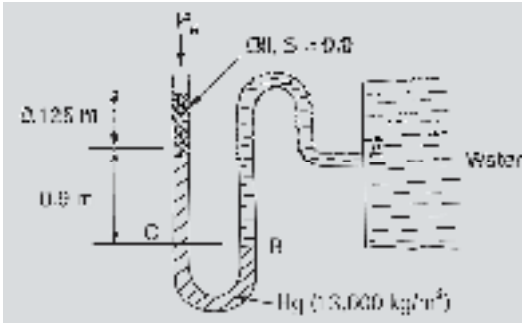

Figure 1

b. 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)**

QUESTION FIVE (20 MARKS)

a. Explain the principles of liquids in relative equilibrium and show that the linear acceleration; f, of a tank containing water is given by; $f = g\tan\theta$; where is the angle of the free surface to the to the horizontal, and g is gravitational acceleration. **(6 Marks)**

b. Describe the importance and difference of over-turning moment and the righting moment with respect to floating bodies. **(6 Marks)**

c. A ship weighing 4000 tons and having an area of 465 m^2 at water line submerging to depth of 4.5 m in sea water with a density of 1024 kg/m3 moves to fresh water. Determine the depth of submergence in fresh water. Assume that sides are vertical at the water line. **(8 Marks)**

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