JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE & TECHNOLOGY UNIVERSITY EXAMINATIONS 2012/2013

2ND YEAR 1ST SEMESTER EXAMINATION IN DEGREE OF BACHELOR OF SCIENCE RENEWABLE ENERGY TECHNOLOGY AND MANAGEMENT

(REGULAR)

COURSE CODE: TET 3213

COURSE TITLE: FLUID MECHANICS I

DATE: 19/8/13 **TIME: 9.00 – 11.00 AM**

DURATION: 2 HOURS

INSTRUCTIONS

1. **This paper contains five (5) questions.**
2. **Answer question 1 (compulsory) and ANY other TWO questions.**
3. **Write all answer in the booklet provided.**

QUESTION 1 (30 MARKS)

a. Briefly explain the following terms as applied in fluid mechanics giving relevant equations where possible.

i. Conservation of mass **(2 Marks)**
ii. Conservation of energy **(2 Marks)**
iii. Conservation of momentum **(2 Marks)**
iv. Ideal fluid **(2 Marks)**
v. Steady flow **(2 Marks)**

b. Pascal's principle states that the pressure at a point in a fluid at rest is equal in all directions. In reference to a small element of fluid at rest, show that;

$P_x = P_y = P_z$; where P represents the pressure on the element in the directions, *x*, *y* and *z*. **(8 Marks)**

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

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

QUESTION 2 (20 MARKS)

a. Explain the parallel axes theorem and how it is applied to determine the centre of pressure. **(8 Marks)**

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 3 (20 MARKS)

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

b. 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)**

c. A vessel has a displacement of 2500 tonnes of fresh water. A mass of 20 tonnes moved 9m across the deck causes the lower end of a pendulum 3m long to move 23cm horizontally. Calculate the transverse metacentric height. **(6 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 vertical dock gate is 5.5 m wide and has water to a depth of 7.3 m on one side, and to a depth of 3 m on the other side. Find the resultant horizontal force on the dock gate and the position of its line of action.
To what position does this line tend as the depth of water on the shallow side rises to 7.3 m? **(8 Marks)**

QUESTION 5 (20 MARKS)

Derive Euler's equation from first principles and show its relationship with the Bernoulli's equation. State the assumptions made in the derivation process.

(20 Marks)