JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

UNIVERSITY EXAMINATIONS FOR THE DEGREE OF SCIENCE IN:

RENEWABLE ENERGY TECHNOLOGY AND MANAGEMENT

2ND YEAR 1ST SEMESTER 2015/2016 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: TET 3213

COURSE TITLE: FLUID MECHANICS I

EXAM VENUE: W/S **STREAM: BSc RE. ENERGY TECH AND MGT**

DATE: 28/4/16 **EXAM SESSION: 9.00 – 11.00 AM**

TIME: 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 importance of **"fluid mechanics"** to you as a student studying BSc. In Renewable energy Technology and Management. **(3 Marks)**

b. Differentiate the following as applied in fluid mechanics; **(8 Marks)**
   i. Ideal fluid and real fluid
   ii. Laminar flow and turbulent flow
   iii. Steady flow and unsteady flow
   iv. Uniform flow and non-uniform flow

c. Explain the following properties as applied in fluid mechanics; **(9 Marks)**
   i. Compressibility of fluid deriving the expression for bulk modulus of elasticity (*K*)
   ii. Surface tension deriving expression for coefficient of surface tension (σ) in terms of capillary rise.
   iii. Newton's Law of Viscosity deriving expression for shear stress (τ)

d. Explain the following principles and their importance in fluid mechanics (use mathematical expressions where applicable);
   i. Parallel axis theorem and its application **(5 Marks)**
   ii. Conservation of energy **(3 Marks)**
   iii. Continuity equation **(2 Marks**

QUESTION 2 (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 from first principles 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. Use the expression of h_c above, to show that the centre of force acting on a vertical rectangular plane surface with its upper edge in the free surface of the fluid is at two thirds the depth (vertical height). **(8 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. An oil tank is filled to a height of 7.5 m with an oil of specific gravity 0.9. It has a rectangular gate 1m wide and 1.5 m high provided at the bottom of a side face. Determine the resultant force on the gate and also its point of action. **(8 Marks)**

b. A tank 20 m deep and 7 m wide is layered with 8 m of oil, 6 m of water and 4 m of mercury. Determine the total hydrostatic force and resultant centre of pressure on the side. Specific gravity of oil is 0.881 and that of mercury is 13.6. **(12 Marks)**

QUESTION 5 (20 MARKS)

a. Derive Euler's equation outlining its relationships with Bernoulli's equation. State any assumptions and define all terms used in each equation. **(16 Marks)**

b. Apply the basic equations of static fluids (*a* and *b*) to both sides of inclined manometer and show that;

$$P_a - P_b = gR_m(\rho_b - \rho_a)$$ **(4 Marks)**