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 2ND SEMESTER 2023/2024 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: TEB 1206

COURSE TITLE: FLUID MECHANICS II

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

DATE: /04/2024 **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 ONE (30 MARKS)

a. Outline the significance of dimensional analysis as applied in fluid mechanics **(4 Marks)**

b. Outline the difference between "Raleigh's method" and "Buckingham's π theorem" as applied in dimensional analysis. **(6 Marks)**

c. Briefly explain what you understand by dimensionless numbers, hence the following and their areas of application. **(6 Marks)**
   i. Reynolds number
   ii. Mach's number

d. The drag force on a smooth sphere is found to be affected by the velocity of flow, *u*, the diameter of the sphere, *D*, and the fluid properties density ρ, and viscosity μ. Using dimensional analysis obtain the dimensionless groups and correlate the parameters showing a possible form of equation describing the situation. **(9 Marks)**

e. The analysis of fluid flow phenomena fundamentally depends upon the application of Newton's laws of motion together with recognition of the special properties of fluids in motion. Describe these laws showing equations where applicable. **(5 Marks)**

QUESTION TWO (20 MARKS)

a. Briefly describe what you understand by dynamic similarity and its application in model experimentation. **(6 Marks)**

b. The thrust force, F generated by a propeller is found to depend on the following parameters: diameter D, forward velocity u, density ρ, viscosity μ and rotational speed N. Determine the dimensionless parameters to correlate the phenomenon.;

$$\frac{F}{\rho U^2 D^2} = f\left(\frac{UD\rho}{\mu}, \frac{ND}{U}\right)$$ **(14 Marks)**

QUESTION THREE (20 MARKS)

a. Using a labelled sketch and from first principles, derive the expressions of the force exerted by a horizontal jet of fluid on: (State any assumptions made)
   i. A moving flat inclined surface **(4 Marks)**
   ii. A moving curved surface **(4 Marks)**

b. A jet 30 mm diameter with velocity of 10 m/s strikes a vertical plate in the normal direction. Determine the force on the plate if
   (i) The plate is stationary **(6 Marks)**
   (ii) If it moves with a velocity of 4 m/s towards the jet and (iii) If the plate moves away from the plate at a velocity of 4 m/s. **(6 Marks)**

QUESTION FOUR

a. Show from first principles that the simple theoretical rate of flow, *Q*, through a rectangular weir is given by;

$Q = \frac{2}{3} C_d b \sqrt{2gh^{3/2}}$; where b=width of the weir, h= height of water level above the bottom of the weir, g=gravitational acceleration, C_d=coefficient of discharge. **(8 Marks)**

a. Show from first principles that the simple theoretical rate of flow, *Q*, through a right-angled V-notch is given by;

$Q = \frac{8}{15} C_d \sqrt{2g} H^{5/2}$; Where H= height of water level at the top width of the weir, g=gravitational acceleration, C_d=coefficient of discharge. **(12 Marks)**

QUESTION FOUR (20 MARKS)

b. Outline the procedure and the equations applied in determining time taken to empty a large diameter tank through an orifice (small opening) at the bottom. **(5 Marks)**

c. A pipeline with a constant diameter of 0.3m turns through an angle of 60^o. The centerline of the pipe does not change elevation. The discharge through the pipeline is $0.1m^3/s$ of water, and the pressure at the bend is 30m of water. Calculate the magnitude and direction of the resultant force on the pipe. **(15 Marks)**

QUESTION FIVE (20 MARKS)

a. A pitot static tube is used to measure the velocity of air flowing through a duct. The manometer shows a difference in head of 5 cm of water. If the density of air and water are 1.13 kg/m^3 and 1000 kg/m^3 determine the velocity of air. Assume the coefficient of the pitot tube as 0.98. **(5 Marks)**

b. Derive the expression for computing discharge through a Venturimeter. Hence calculate the coefficient of discharge for a venturimeter of 150 mm × 75 mm size used to measure the flow rate of oil having specific gravity of 0.9. The reading shown by the U tube manometer connected to the venturimeter is 150 mm of mercury column. The flow rate is 1.7 m3/min. (NB: The size of venturimeter is specified in terms of inlet and throat diameters).

(15 Marks)