(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER

MAIN EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

COURSE CODE: **MAT 414**

COURSE TITLE: **FLUID MECHANICS II**

DATE: 16/05/2022 **TIME:** 9:00 AM - 11:00 AM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of 3 Printed Pages. Please Turn Over.

QUESTION ONE (30 MARKS)

a. Define the following terms as used in Fluid Mechanics (5 marks)
   i. Streamline
   ii. Dynamic similarity
   iii. Kinematic Similarity
   iv. Dimension
   v. Boundary layer.

b. Consider a flow described by $W = z^2$. Determine its stream function, velocity potential and the streamlines. (6 marks)

c. Find the Dimensions of kinematic viscosity, ν. (6 Marks)

d. In the boundary layer over the face of a high spillway, velocity distribution was observed to have the following form $\frac{u}{U} = \left(\frac{y}{\partial}\right)^{0.22}$. The free stream velocity U at a certain section was observed to be 30 ms^{-1} and a boundary layer thickness of 60 mm was estimated from the velocity distribution measured at the section. The discharge passing over the spill way was $6m^3s^{-1}$. Calculate the energy thickness. (7 marks)

e. Derive the Caurchy Riemann equation in polar form. (6 marks)

QUESTION TWO (20 MARKS)

A two dimensional flow field is given by $\psi = xy$.

a). Show that the flow is irrotational. (5 marks)

b). Find the velocity potential. (5 marks)

c). Verify that ϕ and ψ satisfy laplace equation. (5 marks)

d). Find the streamline and potential lines. (5 marks)

QUESTION THREE (20 MARKS)

a). Derive the Navier stoke equation. (10 marks)

b) A geometrically similar model of an air duct is built to $\frac{1}{25}$ scale and tested with water which is 50 times more viscous and 800 times denser than air. When tested under dynamically similar conditions, the pressure drop is 2×10^5 N/m^2 in the model. Find corresponding pressure drop in the prototype and express in water column. (Take density of water to be 1000$kg/m^3$and g= 10 N/kg) (10 marks)

QUESTION FOUR (20 MARKS)

Using Buckingham's π-method, show that the velocity through a circular orifice is given by

$$V = \sqrt{2gH}.\phi\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$$

Where H – head causing flow

μ - coefficient of viscosity

g – acceleration due to gravity

D – Diameter of the orifice

ρ - Density (20 marks)

QUESTION FIVE (20 MARKS)

a. Explain the following as used in Fluid Mechanics
   i. Kinematic similarity. (2 marks)
   ii. Dynamic similarity. (2 marks)
   iii. Reynolds number. (2 marks)

b. A ship 200 m long moves in a sea-water; whose density is 1030kgm^{-3}. A 1:100 model of the ship is tested in a wind tunnel. The velocity of air in the model is 30 m/s and the resistance of the model is 60N. Determine the velocity of the ship in sea water and also the resistance of the ship in sea water. The density of air is given as 1.24 kgm^{-3}. Take the kinematic viscosity of sea water and air as 1.2x10^{-6}m^2/s and 1.8x10^{-6}m^2/s respectively. (14 marks)