(Knowledge for Development)

# KIBABII UNIVERSITY

## UNIVERSITY EXAMINATIONS

## 2020/2021 ACADEMIC YEAR

## FOURTH YEAR FIRST SEMESTER

## MAIN EXAMINATION

## FOR THE DEGREE OF BACHELOR OF SCIENCE

**COURSE CODE:** **MAT 425**

COURSE TITLE: **FLUID MECHANICS II**

**DATE:** 13/7/2021 **TIME:** 9 AM – 11 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 (6 marks)
   i. Streamline
   ii. A sorce
   iii. A sink
   iv. Stagnation point
   v. Dimension
   vi. Boundary layer.
b. Derive the Cauchy Riemman equation in polar form. (6 marks)
c. Find the Dimensions of
   i. Discharge
   ii. Force (4 marks)
d. The velocity of a Fluid is given as $q = -xi + (y + t)j$. Find the stream function and streamlines for this field at t=2 seconds. (7 marks)
e. Derive the Navier Stoke equation. (7 marks)

## QUESTION TWO (20 MARKS)

a. Consider the complex potential $W = \Phi + i\psi$ and let $z = x + iy$. If $W = f(z)$, derive the Cauchy Riemman equations. (10 marks)
b. A two dimension flow field is given by $\psi = 2x + y$.
i. Show that the flow is irrotational
ii. Find the velocity potential
iii. Find the streamlines and potential lines. (10 marks)

## QUESTION THREE (20 MARKS)

The Resistance R experienced by a partially submerged body depends upon the velocity $V$, length of the body $l$, viscosity of the fluid μ, density of the fluid ρ and gravitational acceleration $g$. Using the Buckingham's π-method, obtain a Dimensionless expression for R. (20 Marks)

## QUESTION FOUR (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)

## QUESTION FIVE (20 MARKS)

The velocity distribution in the boundary layer is given by $u/U=3y/2\delta-y^2/2\delta^2$, $\delta$ being the boundary layer thickness. Calculate:

a. The ratio of displacement thickness to the boundary layer thickness. (5 marks)
b. The ration of momentum thickness to boundary layer thickness. (7 marks)
c. The energy thickness taking $\delta = 60\,mm$. (8 marks)