(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS 2020/2021 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER
MAIN EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION

COURSE CODE: MAA 313

COURSE TITLE: FLUID MECHANICS I

DATE: 13/7/2021 **TIME:** 2:00 – 4: PM

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 (COMPULSORY) (30 MARKS)

(a)Explain the following properties of fluids.

i. Specific weight
ii. Specific volume
iii. Specific heat (3marks)

(b) Deduce the relationship between specific weight and density of a fluid. (3 marks)

(c) Explain the following types of fluid flow. (5marks)

i. Barotrophic flow
ii. Lamina flow and turbulent flow
iii. Uniform flow and non-uniform flow

(d) A 3D flow is given by

$$u = (yz + t)i$$
$$v = (xz - t)j$$
$$w = (xy)k$$

Find the acceleration at P(1,2,3) after 1 second (4marks)

(e)Explain the following

i. Streak line
ii. Stream line (3marks)
iii. Path line

(f) Water flows through 0.4m pipe at a rate of 3000l per minute, at another section the pipe diameter reduces to 0.16m. What are the average velocities of the flow at the two sections? (4marks)

(g) A 2D flow field is given by $\emptyset = 3xy$. (8 marks)

i. Determine the stream function
ii. Determine velocity at A(1,3) and B(3,3)
iii. What is the discharge between the streamlines passing through these points?

QUESTION TWO

(a) State Bernoulli's equation for incompressible fluid. (2marks)

(b) Starting with Euler's Equation of motion derive Bernoulli's equation (12marks)

(c) A liquid of specific gravity of 1.3 flows in a pipe at a rate of 800 l/s from point A to point B, which is 1m above point A. The diameters at section A and B are 0.6m and 0.3m respectively. If the pressure at section A is 10 bar. Determine the pressure of section B. (6marks)

QUESTION THREE

A velocity field is given by $q = \frac{-yi+xj}{x^2+y^2}$.

Determine whether the flow is irrotational and calculate the circulation Around

i. Square with its corners (1,0)(2,0)(2,1)(1,1) . (10marks)
ii. Unit cycle with center at the origin. (10marks)

QUESTION FOUR

(a)A space is bounded by an ideal fixed surface S drawn in a homogeneous incompressible fluid satisfying the condition for the existence of velocity potential V. Prove that the rate per unit times at which energy flows across is the space bounded by s' is given by $-\rho \iint \frac{\partial \emptyset}{\partial t} \cdot \frac{\partial \emptyset}{\partial n} ds$ where ρ is density , ∂n is an element drawn to the normal of ∂s. (5marks)

(b) Show that for a diabetic process $p\rho^{-r} = constant$ where $r = \frac{C_P}{C_V}$. (7marks)

(c) Define entropy. (2marks)

(d). Expressing the entropy S and internal energy E in terms of pressure P and volume V. Show t $\left(\frac{\partial S}{\partial V}\right) p = \frac{Cp}{T\partial V}$ and $\left(\frac{\partial S}{\partial P}\right) v = \frac{Cv}{\partial kT}$ (6marks)

QUESTION FIVE

(a) State the law of conservation. (2marks)

(b) Write the continuity equation in cylindrical coordinates for compressible fluid and incompressible fluid. (4marks)

(c) From the properties of stream, prove that φ is constant along a stream line. (4marks)

(d) Examine whether the velocity component is given by $u = xy, v = 2yz$ represents 2D OR 3D incompressible fluid then determine its stream function. (10marks)