(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2022/2023 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER

MAIN EXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION AND BACHELOR OF SCIENCE (MATHEMATICS)

COURSE CODE: MAA 313

COURSE TITLE: FLUID MECHANICS I

DATE: 15/12/2022 **TIME: 2:00 PM – 4: 00PM**

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of 2 Printed Pages. Please Turn Over.

QUESTION ONE (30 MARKS)

(a) Distinguish between the following as used in fluid mechanics;

(i) Viscous fluid and Inviscid fluid **(2mks)**

(ii) Irrotational and rotational flow **(2mks)**

(b) State the first law of Thermodynamics **(2mks)**

(c) A liquid compressed in a cylinder has a volume of $0.4cm^3$ at a pressure of $6.8\times10^7\ N/cm^2$ and volume of $0.396cm^3$ at a pressure of $1.36x10\times10^8\ N/cm^2$. Calculate the Bulk modulus of the fluid. **(4mks)**

(d) Prove that for adiabatic process, $P\rho^{-\gamma}=$ a constant, where $\gamma = C_P/C_V$ **(8mks)**

(e) Determine the dimension of the coefficient of viscosity **(3mks)**

(f) Show whether or not the continuity equation is satisfied given the following;

$u = x^3 - y^3 - z^3x,\ v = y^3 - x^3,\ w = -3x^2z - 3y^2z + z^3$ **(4mks)**

(g) The velocity along streamline is given by $v = (2s + t + 1)m/s$. Find the acceleration and velocity at $s = 2m$ after $1s$ **(5mks)**

QUESTION TWO (20 MARKS)

(a) Determine which of the velocity component sets given below satisfy the equation of continuity;

(i) $u = A\sin(xy),\ v = -A\sin(xy)$ **(3mks)**

(ii) $u = x + y,\ v = x - y$ **(3mks)**

(iii) $u = 2x^2 + 3y,\ v = -2xy + 3y^3 + 3zy,\ v = -\frac{3}{2}z^2 - 2xz - 6yz$ **(4mks)**

(b) Find the equation of the streamline given that $u = \frac{-K^2y}{x^2+y^2};\ v = \frac{K^2x}{x^2+y^2}$ **(10mks)**

QUESTION THREE (20 MARKS)

Test whether the motion specified by $\vec{q} = \frac{K^2(xj - yi)}{x^2 + y^2}$, with K as a constant,

(a) Is a possible motion for an incompressible fluid **(5mks)**

(b) Test whether the motion is of the potential kind, hence or otherwise determine the velocity potential **(15mks)**

QUESTION FOUR (20 MARKS)

(a) Prove that $C_P - C_V = R$ where R is a gas constant. **(8mks)**

(b) The velocity of a point in a fluid for a 1-D flow may be given in Eulerian co-ordinates by $u = Ax + Bt$ where A and B are constants. Find the displacement of a fluid particle in Langrangian system given that the initial conditions are $x = x_o$, $t = t_0 = 0$ may be assumed.

(12mks)

QUESTION FIVE (20 MARKS)

(a) Find the velocity component of a fluid particle when the velocity distribution is given by

$\vec{q} = i(Ax^2 y) + j(By^2 zt) + k(czt^2)$ **(5mks)**

(b) Given that $u = \frac{ax - by}{x^2 + y^2}$; $v = \frac{ay + bx}{x^2 + y^2}$; $w = 0$

(i) Investigate the nature of the fluid motion. **(10mks)**

(ii) Show that the velocity potential is given by $\Phi = -\left\{\frac{a}{2}\ln\left(x^2 + y^2\right) + b\tan^{-1}\left(\frac{y}{x}\right)\right\}$

(5mks)