ALUPE UNIVERSITY
OFFICE OF THE DEPUTY VICE CHANCELLOR
ACADEMICS, RESEARCH AND STUDENTS AFFAIRS

UNIVERSITY EXAMINATIONS
2023/2024 ACADEMIC YEAR

FIRST YEAR FIRST SEMESTER REGULAR MAIN EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE COMPUTER SCIENCE

COURSE CODE: **MAT 417E**
COURSE TITLE: **FLUID MECHANICS**

DATE: 13th JAN 2024 **TIME:11:00-2:00PM**

INSTRUCTION TO CANDIDATES

- **SEE INSIDE**

THIS PAPER CONSISTS OF 3 PRINTED PAGES **PLEASE TURN OVER**

REGULAR – MAIN EXAM

MAT 417E: FLUID MECHANICS

STREAM: BED **DURATION: 3 Hours**

INSTRUCTION TO CANDIDATES

i. *Answer **ALL** questions from **section A** and any **THREE** from **section B***

ii. *Do not write on the question paper.*

SECTION A (31 MARKS): Answer all questions in this section.

QUESTION ONE (16 MARKS)

a) Name and define the types of fluids (4mks)

b) Derive the equation of streamlines for a steady or unsteady, uniform or non-uniform, viscous or inviscid and compressible or incompressible three dimensional flow (4mks)

c) Given $u = -x + t + 2, v = y - t + 2$, determine the path lines. (3mks)

d) A stream in a horizontal pipe after passing a constriction whose cross sectional area is A is delivered at a atmospheric pressure at a a place where the cross-sectional area is B. If is a side tube is connected with the pipe at the point where the cross-sectional area is A, water will be sucked up through it into the pipe from a reservoir at a depth (h) given by $h = \frac{s^2}{2g}\left(\frac{1}{A^2} - \frac{1}{B^2}\right)$ below the pipe. s being the delivery per second. Prove this finding by applying Bernoulli and continuity equations.

(5mks)

QUESTION TWO (15 MARKS)

a) Name the main thermodynamic variables (5mks)

b) Prove that $C_p - C_v = R$ where R is the gas constant (10mks)

SECTION B: ANSWER ANY THREE QUESTIONS

QUESTION THREE (13 MARKS)

a) The velocity field in a fluid is given as $\vec{q} = 5x^3 i - 15yx^2 j$. Determine

i. The fluid velocity at an instant point P(1,1,1) (2mks)

ii. The acceleration of this fluid at any time, t (5mks)

b) In a two dimensional flow , defined by the following velocity field $\vec{q} = \frac{-y}{b^2} i + \frac{x}{a^2} j$ where a and b are constants, determine the equation of the streamline of this flow passing through point X(a,0).Sketch the flow pattern. (6mks)

QUESTION FOUR (13 MARKS)

a) Define the 1st law of thermodynamics (4mks)

b) Given $u = 2y, v = -2x$ .Determine:

i. the stream function, (5mks)

ii. the streamlines (4mks)

QUESTION FIVE (13 MARKS)

A long straight pipe of length L has a slowly tapering circular cross-sectional area. Its inclined so that it makes an angle α to the horizontal with its smaller cross-section downwards. The radius of the pipe at the upper end is twice that at the lower end. If water is pumped at a steady rate through the pipe to emerge at atmospheric pressure π and the pumping pressure is twice the emerging pressure, show that the fluid leaves the pipe with speed $\mu^2 = \frac{32}{15}\left[gL\sin\alpha + \frac{\pi}{\rho}\right]$ where ρ is the fluid density and g is the gravitational acceleration. (13mks)

QUESTION SIX (13 MARKS)

Given that $U = \frac{-c^2 y}{r^2}, V = \frac{c^2 x}{r^2}, w = 0$, where r denotes distance from z-axis, determine

i. The streamlines of the flow (5mks)

ii. Is the motion possible? (5mks)

iii. is it irrotational? (3mks)

QUESTION SEVEN (13 MARKS)

Given that the potential ϕ of a flow is defined as $\phi = \frac{1}{2}\log\frac{(x+a)^2 + y^2}{(x-a)^2 + y^2}$, determine whether the flow exist, hence find the velocity vector for this flow (13mks)