(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2017/2018 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER

MAIN EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

(MATHEMATICS)

COURSE CODE: MAT 325

COURSE TITLE: FLUID MECHANICS I

DATE: 12/01/18 **TIME:** 2 PM -4 PM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of 4 Printed Pages. Please Turn Over.

QUESTION ONE (30 MARKS)

a) Define the following terms (4 Marks)

(i) Fluid dynamics

(ii) Pathlines

(iii) Streamlines

(iv) Barotrophic flow

b) State the equation of continuity for steady incompressible flow (2 Marks)

c) A three dimensional flow is given by $u = yz + t, v = xz - t, \ w = xy$. Find the velocity and accellaration at P(1, 2, 3) after 1 sec (5 Marks)

d) Fluid velocity and temperature of a two dimensional flow field are given by

$$\boldsymbol{V} = 2xy\boldsymbol{i} + (xt - y^2)\boldsymbol{j}$$

$$T = 10 + x^2 + yt$$

What is the rate of change in temperature in fluid flow at P(2,1) after 2 secs. (5 Marks)

e) Show that in a 2 dimensional incompressible steady flow field, the equation of continuity is satisfied with the velocity components

$$u(x,y) = \frac{k(x^2 - y^2)}{x^2 + y^2} \quad v(x,y) = \frac{2kxy}{x^2 + y^2}$$

Where k is a constant (6 Marks)

f) A 2D flow fluid is given by $\psi = xy$

(i) Show that the flow is irrotational (3 Marks)

(ii) Verify that ψ and ϕ satisfies laplace equation (3 Marks)

(iii) Find the streamlines and potential lines (2 Marks)

QUESTION TWO (20 MARKS)

a) State the zeroth law of thermodynamics (2 Marks)

b) Differentiate between Lagrangian and Eulerian method of description of fluid motion (2 Marks)

c) The velocity components for a 2D fluid system can be given in Eulerian system by $u = 2x + 2y + 3t, v = x + y + \frac{t}{2}$. Find the displacement of a fluid particle in the Lagrangian system. (8 Marks)

d) Prove the Bernoullis equation for steady irrotational motion for an incompressible fluid. (8 Marks)

QUESTION THREE (20 MARKS)

a) State and Prove Kelvin's circulation theorem (7 Marks)

b) A velocity field is given by

$$q = \frac{-yi + xj}{x^2 + y^2}$$

Determine whether the flow is irrotational and hence calculate the circulation round a unit circle with centre at the origin (8 Marks)

a) Examine whether the velocity components given by

$$u = -4ax(x^2 - 3y^2)$$

$$v = 4ay(3x^2 - y^2)$$

Represent a physically two dimensional flow, if so whether the flow is rotational or irrotational (5 marks)

QUESTION FOUR (20 MARKS)

a) Differentiate between the following types of flow (4 Marks)

(i) Rotational and irrotational flow

(ii) Uniform and non-uniform flow

b) A two dimensional flow field is given by $\phi = 2xy$

(i) Determine the stream function (3 Marks)

(ii) Determine the velocities at A(2,6) and B(6,6) (3 Marks)

c) The velocity field at a point in a field is given as $q = \frac{x}{t}i + yj$. Obtain the equations of pathlines and streaklines. (10 Marks)

QUESTION FIVE (20 MARKS)

a) State the continuum hypothesis (4 Marks)

b) A horizontal pipe gradually reduces in diameter from 24m to 12m. Determine the total longitudinal thrust exerted on the pipe if the pressure at the larger end is 50 N/M^2 and the velocity of water is 96m/sec. (6 Marks)

c) Obtain by use of a well labeled diagram, a derivative of equation of continuity in integral form (6 Marks)

d) A two dimensional flow field is given by

$$V = (3 + 2xy + 4t^2)i + (xy^2 + 3t)j$$

Find the velocity and acceleration at A(1,2) after 2seconds (4 Marks)