(10)

(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2017/2018 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER

SPECIAL/ SUPPLEMENTARY EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

MATHEMATICS

COURSE CODE: MAT 325

COURSE TITLE: FLUID MECHANICS I

DATE: 04/10/18 **TIME:** 8 AM -10 AM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

QUESTION ONE (30 MARKS)

a) Differentiate between specific weight and relative density as used in fluid mechanics, giving their units in each case. (4 marks)

b) Obtain the stream lines of a flow $u = x, \quad v = -y$ (4 marks)

c) Briefly explain one application of hydrostatics (5 Marks)

d) State the first law of thermodynamics and show that $C_V = 3V\left(\frac{\partial P}{\partial T}\right)_V$, $C_P = 4P\left(\frac{\partial V}{\partial T}\right)_P$ by taking $E = 3PV$ (6 Marks)

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

$$u(x,y) = \frac{K(x^2 - y^2)}{(x^2 + y^2)^2}, \qquad v(x,y) = \frac{2Kxy}{(x^2 + y^2)^2}$$

Where K is a constant (6 Marks)

f) Describe the continuum hypothesis as used in fluid dynamics (5 Marks)

QUESTION TWO (20 MARKS)

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

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

i) Determine whether the flow is irrotational (3 Marks)

ii) Calculate the circulation around a square with its corners at $(1,0), (2,0), (2,1), (1,1)$ (7 Marks)

QUESTION THREE (20 MARKS)

a) Using a well labeled diagram, show that the rate of increase of pressure in a vertically downward direction must be equal to the specific weight of the fluid at that point (Hydrostatic law) (6 Marks)

b) The velocity components for a two dimensional fluid system is given in Eulerian system by $u = 2x + 3y + 3t, \quad v = x + y + \frac{1}{2}t$. Find the displacement of a fluid in the Lagrangian system (10 Marks)

c) Differentiate between (4 Marks)

(i) Uniform and non uniform flow

(ii) Rotational and irrotational flow

QUESTION FOUR (20 MARKS)

a) 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. (7 Marks)

b) A closed tank contains water up to a depth of 3m and above it oil of specific gravity 0.9 for a depth of 2m. Find the pressure

(i) At the interface of the two liquids (3 Marks)

(ii) At the bottom of the tank (2 Marks)

c) Water enters a house through a pipe 5cm in inside diameter at absolute pressure of $1 \times 10^5 \ Pa$. The pipe leading inside the house to the second floor 2.5m above has an inside diameter of 3cm. When the flow velocity at the inlet pipe is 1.5m/s and upstairs bathroom is 4.2m/s, what is the pressure at upstairs bathroom? (4 Marks)

d) A nozzle on a hose accelerates water from 4cm diameter to 1cm diameter. If the pressure is 400kPa upstream of the nozzle, what is the maximum velocity of water exiting the nozzle? (4 Marks)

QUESTION FIVE (20 MARKS)

a) Obtain, by use of a well labeled diagram, a derivation of the equation of continuity in Cartesian coordinate system . (11 Marks)

b) State the zeroth law of thermodynamics. (2 Marks)

c) By expressing internal energy E in terms of pressure P and volume V, show

that $C_V = \left(\frac{\partial E}{\partial P}\right)_V \left(\frac{\partial P}{\partial T}\right)_V$ and $C_P = \left[P + \left(\frac{\partial E}{\partial V}\right)_P\right]\left(\frac{\partial V}{\partial T}\right)_P$

Also, show that $\left(\frac{\partial E}{\partial T}\right)_V = T\left(\frac{\partial S}{\partial T}\right)_V$ *and* $\left(\frac{\partial E}{\partial V}\right)_T = T\left(\frac{\partial S}{\partial V}\right)_T - P$ (7 Marks)