TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF MATHEMATICS & COMPUTER SCIENCE

AMA 4324: FLUID MECHANICS I

END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2014
TIME ALLOWED: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FIVE** questions
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **THREE** printed pages

Question One (Compulsory)

a) Explain the following terms:
- **(i)** Specific weight
- **(ii)** Specific volume
- **(iii)** Specific gravity **(3 marks)**

b) A researcher of carbon tetrachloride (CCL4) has a mass of 500kg and a volume of $0.315m^3$. Calculate the following properties of carbon tetrachloride
- **(i)** Weight
- **(ii)** Density
- **(iii)** Specific weight
- **(iv)** Specific gravity **(6 marks)**

c) An open tank contains 5.7m of water covered with 2.8m of Kerosene 1w = 8KN/m^3. Find the pressure at the interface and at the bottom of the tank **(4 marks)**

d) Define a Newtonian fluid **(3 marks)**

e) A plate of 0.025m distance from a fixed plate, moves at 60cm/s and requires a force of 2N/m^2 to maintain this speed. Calculate the fluid viscosity between the plates **(4 marks)**

f) A head of water over an orifice of diameter 100mm is 10m. The water coming out from orifice is collected in a circular tank of diameter 1.5. The rise of water level in this tank is 1.0m in 25 seconds. Also the coordinates of a point on the jet measured from vena contracts are 4.3m horizontal and 0.5 vertical. Find the following coefficient Cd, Cv and Cc **(10 marks)**

Question Two

a) Define the following types of flows:
   (i) Steady flow
   (ii) Uniform flow
   (iii) Rotational flow
   (iv) Laminar flow **(5 marks)**

b) A 30m diameter pipe, conveying water branches into two pipes of diameter 20cm and 1cm respectively. if the average velocity in the 30cm diameter pipe 2.5m/s. Find the discharge in this pipe and also calculate the velocity in the 15cm pipe if the average velocity in 20m diameter pipe is 2m/s **(3 marks)**

c) The velocity vector in a fluid flow is given:

$$V = 4x^3 j - 10x^2 yj + 2tk$$

Find the velocity and acceleration of a fluid particle at (2, 1, 3) at time t = 1 **(8 marks)**

Question Three

a) Explain the following types of heads of flowing liquid:
   (i) Potential head
   (ii) Velocity head
   (iii) Pressure head
   (iv) Total head **(4 marks)**

b) Derive the Bernoulli's equation **(6 marks)**

c) State the assumptions made in deriving of Bernoulli's equation **(3 marks)**

d) The water is flowing through a tapering pipe having diameters 300mm and 150mm at sections 1 and 2 respectively. The discharge through the pipe is 40 titles/sec. The section 1 is 10m above datum and section 2 is 6m above datum. Find the intensity of pressure at section 2 if that at section 1 is 400KNm^2

Question Four

a) Define and explain the following:

(i) Velocity potential
(ii) Stream function **(4 marks)**

b) The velocity potential function (ϕ) is given by an expression:

$$\phi = -\frac{xy^3}{3} - x^2 + \frac{x^3 y}{3} + y^2$$

(i) Find the velocity components in x and y direction
(ii) Show that ϕ represents a possible case of flow **(10 marks)**

c) Sketch the stream lines represented by $y = x^2 + y^2$. Also find out the velocity and its direction at point (1, 2) **(6 marks)**

Question Five

a) An Isosceles triangle of base 3 metres and altitude 6 metres is immersed vertically in water, with its axis of symmetry horizontal as shown in figure 1 below. If the head of water on it is 9 metres, calculate:
(i) Total pressure on the plate
(ii) The position of the centre of pressure **(5 marks)**

b) A body of dimensions 1.5m x 1.0m x 2m weighs 196.2N in water. Find its weight in air. What will be its specific gravity. **(4 marks)**

c) Describe the following gas:
(i) Idea gas
(ii) Perfect gas **(2 marks)**

d) State Boyle's Law and Charles Law **(2 marks)**

e) A steel flask of 0.04m^3 capacity is to be used to store nitrogen at 120bar 20^{o}C. The flask is to be protected against excessive pressure by a fusible plug which will melt and allow the gas to escape if the temperature raises to high
(i) How many kg of nitrogen will the flask hold at the designed conditions.
(ii) At what temperature must the fusible plug melt in order to limit the pressure of a full flask to a maximum of 150 bar
(R_o = 8.3143KJ/kgmolK) **(7 marks)**

The water surface

Fig 1