



KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2010/2011

INSTITUTIONAL BASED PROGRAMME (IBP) – AUGUST SESSION
EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE (APPLIED
MATHEMATICS)

SMA 532: FLUID MECHANICS I

DATE: Tuesday 3rd January, 2012

TIME: 9.00a.m. – 12.00 noon

INSTRUCTIONS:

Answer question **one** and any other **two**.

QUESTION ONE (30 Marks) – (Compulsory)

(a) Briefly explain the following

- (i) Fluid Kinematics [2 Marks]
- (ii) Convective acceleration [2 Marks]
- (iii) Local (temporal) acceleration [2 Marks]
- (iv) Incompressible flow [2 Marks]
- (v) Turbulent flow [2 Marks]
- (vi) Two dimensional flow. [2 Marks]

(b) Differentiate between

- (i) Rotational and irrotational flow. [3 Marks]
- (ii) Stream tube and streak line. [3 Marks]

(c) In a fluid, the velocity field is given by

$$\vec{V} = (8x + 2y)\mathbf{i} + (8z + 8x^2)\mathbf{k} + (8t - 3z)\mathbf{j}$$

- (i) State the velocity components u , v and w at any point in the flow field. [3 Marks]

- (ii) Determine the speed at point (2, 2, 2) [3 Marks]
- (iii) Determine the speed at time $t = 2s$ at point (0, 0, 3). [3 Marks]
- (iv) Classify the velocity field as steady or unsteady, uniform or non-uniform and one, two, or three dimensioned. [3 Marks]

QUESTION TWO (20 Marks)

- (a) State **five** characteristics of streamlines. [5 Marks]
- (b) A conical pipe diverges uniformly from 200mm to 400mm in diameter over a length of 2m. Determine the local and convective acceleration at the mid-section assuming
 - (a) Rate of flow is $0.24m^3/s$ and remains constant.
 - (b) Rate of flow varies uniformly from $0.12m^3/s$ to $0.48m^3/s$ in 5 sec. at $t = 2$ sec. [15 Marks]

QUESTION THREE (20 Marks)

Show that the continuity equation in polar form is given by

$$\frac{V_r}{r} + \frac{\partial V_r}{\partial r} + \frac{\partial V_\theta}{r \partial \theta} = 0$$

Hence determine whether the following velocity components represents a physically possible flow field

$$V_r = 2r \sin \theta \cos \theta$$

$$V_\theta = -2r \sin^2 \theta$$

[20 Marks]

QUESTION FOUR (20 Marks)

- (a) Define
 - (i) Circulation [2 Marks]
 - (ii) Vorticity [2 Marks]
- (b) Given $u = -8ax(x^2 - 3y^2)$ and $v = 8ay(3x^2 - y^2)$
 Examine whether these velocity components represents a physically possible two-dimensional flow, if so whether the flow is rotational or irrotational? [6 Marks]
- (c) (i) State Bernoulli's equation for real fluid. [3 Marks]

- (iii) A drainage pump has tapered suction pipe. The pipe is running full of water. The pipe diameters at the inlet and at the upper end are 1m and 0.5m respectively. The free water surface is 2m above the centre of the inlet and centre of upper end is 3m above the top of free water surface. The pressure at the tip end of the pipe is 25cm of mercury and it is known that loss of head by friction between top and bottom section is one tenth of the velocity head at the top section. Compute the discharge in litre/sec. Neglect loss of head at the entrance of the tapered pipe.

[7 Marks]

QUESTION FIVE (20 Marks)

- (a) Differentiate between body forces and surface forces, give one example in each case.

[4 Marks]

- (b) Derive momentum equation for a two dimensional case.

[16 Marks]