JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF MATHEMATICAL & ACTUARIAL SCIENCE

UNIVERSITY EXAMINATION FOR THE MASTERS DEGREE

IN APPLIED MATHEMATICS

1ST YEAR 2ND SEMESTER 2013/2014 ACADEMIC YEAR

KISUMU LEARNING CENTRE

COURSE CODE: SMA 841

COURSE TITLE: FLUID MECHANICS I

EXAM VENUE: **STREAM: (MSc.)**

DATE: 30/4/2014   **EXAM SESSION: 9.00 – 12.00 NOON**

TIME: 3 HOURS

<u>Instructions:</u>

1. Answer question 1 (Compulsory)and ANY other 2 questions

2. Candidates are advised not to write on the question paper.

3. Candidates must hand in their answer booklets to the invigilator while in the examination room.

QUESTION ONE (20 marks)

a) Calculate the density, specific weight and weight of one litre of petrol of specific gravity 0.7 .

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(3 marks)

b) State Newton's law of Viscosity and hence distinguish between Newtonian and Non-Newtonian fluids. (4 marks)

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

$$\underline{V} = \left(3x + 2y\right)\hat{i} + \left(2z + 3x^2\right)\hat{j} + \left(2t - 3z\right)\hat{k}$$

Determine

  (i) The velocity components u, v, w at any point in the flow field. (1 mark)

  (ii) The speed at point $(1,1,1)$ (2marks)

  (iii) The speed at time $t = 2s$ at point $(0,0,2)$ (2 marks)

d) Determine the intensity of shear of an oil having viscosity $= 1$ poise. The oil is used for lubricating the clearance between a shaft of diameter $10cm$ and its journal bearing. The clearance is $1.5mm$ and the shaft rotates at 150 $r.p.m$ (8 marks)

QUESTION TWO (20 marks)

a) In a two-dimensional incompressible flow, the fluid velocity components are given by $u = x - 4y$ and $v = -y - 4x$. Show that velocity potential exists and hence determine its form as well as stream function. (7 marks)

b) Two horizontal plates are placed $1.25cm$ apart and the space between them is filled with oil of viscosity 14 poises. Calculate the share stress in oil if the upper plate is moved with a velocity of $2.5m/s$ (7 marks)

c) Find the surface tension in a soap bubble of $40mm$ diameter when the inside pressure is $2.5N/m^2$ above atmospheric pressure. (6 marks)

QUESTION THREE (20 marks)

A pipeline carrying oil of specific gravity 0.8 changes in diameter from $300mm$ at position 1 to $600mm$ diameter at position 2 which is 5 metres at a higher level. If the pressure at positions 1 and 2 are $100KN/m^2$ and $60KN/m^2$ respectively and discharge is 300 $litres/sec$. Determine

  (i) Loss of head (18 marks)

  (ii) Direction of flow (2 marks)

QUESTION FOUR (20 marks)

a) Distinguish between isothermal process and adiabatic process (4 marks)

b) State and prove Bernoulli's theorem (16 marks)

QUESTION FIVE (20 marks)

a) The dynamic viscosity of oil used for lubrication between a shaft and sleeve is 6 poise. The shaft is of diameter $0.4m$ and rotates at 190 $r.p.m.$ Calculate the power lost in the bearing for a sleeve length of $90mm$ if the thickness of the oil film is $1.5mm$. (12 marks)

b) The velocity potential function for a two-dimensional flow is $W = x(2y - 1)$. At a point $P(4,5)$, determine:

  (i) The velocity and (4 marks)

  (ii) The value of the stream function. (4 marks)