TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCE

DEPARTMENT OF MATHEMATICS AND PHYSICS

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MATHEMATICS AND COMPUTER SCIENCE.

AMA 4326: FLUID MECHANICS II

END OF SEMESTER EXAMINATION**: MAY 2016 - SERIES**

TIME: 2 HOURS

Instructions to Candidates

You should have the following to do this examination:

-Answer Booklet, examination pass and student ID

Do not write on the question paper.

Answer question one and any other two

Question one: 30 marks (Compulsory)

a) Briefly describe the following standard conformal transformations:

i) Inversion 1 mark

ii) Enlargement 1 mark

b) Prove that $w = \phi + i\psi$ is an analytic function. 4 marks

c) Two parallel plates kept 100mm apart have laminar flow of oil between them with a maximum velocity of 1.5m/s and viscosity of oil 2.45Ns/m^2.

Calculate: i) The discharge per metre width. 2 marks

ii) The shear stress at the plates. 3 marks

d) Find a relevant stream function for a set of velocity components $u = \frac{-cx}{y}$ and $v = c \ln xy$ to obtain a steady incompressible flow. 6 marks

e) State the Blasius theorem. 3 marks

f) What is the irrotational velocity field associated with the potential $\phi = 3x^2 - 3x + 3y^2 + 16t^2 + 12zt.$ Does the flow field satisfy the incompressible continuity equation? 5 marks

g) Prove that the transformation $w = \frac{1}{z}$ maps the circle $x^2 + y^2 + 2gx + 2fy + c = 0$ in the Z plane onto a circle in the w plane and maps circles in the Z plane through the origin onto a straight line in the w-plane. 5 marks

Question TWO (20 marks)

a) Fluid is in laminar motion between two parallel plates under the action of motion on one of the plates and also under the presence of a pressure gradient in such a way that the net forward discharge across any section is zero:

i) Find out the point where minimum velocity occurs and its magnitude. 7 marks

ii) Draw the velocity distribution profile (sketch graph) across a section of the parallel plates. 2 marks

b) The velocity components in a fluid flow are given by $U = 2xy \quad and \quad V = a^2 + x^2 - y^2$

i) Show that the flow is possible. 2 marks

ii) Derive the relative stream function. 4 marks

c) If streamlines are represented by $\psi = x^2 + y^2$ determine the velocity and its direction at (3, 4) . 5 marks

Question THREE (20 marks)

a) Discuss the flow pattern due to a line source at the origin of a complex potential function. 4 marks

b) In a pipe of 300mm diameter the maximum velocity of flow is found to be 2m/s, if the flow in the circular pipe is laminar. Find :

i) The average velocity and the radius at which it occurs. 5 marks

ii) The velocity at 50mm from the wall of the pipe. 2 marks

c) Consider a conformal mapping $w=\sqrt{z}$, show that the curve $|z-1|=1$ transforms to $\rho^2 = 2\cos 2\phi$ where $w=\rho e^{i\phi}$ in the w - plane. 6 marks

d) Determine a relevant stream function to a set of velocity components of steady incompressible flow if u=2cx and v = -2cy. 3 marks

Question FOUR (20 marks)

a) Define the following terms as used in fluid mechanics:

i) Incompressible flow. 1 mark

ii) Equipotential line. 1 mark

b) Discuss the flow due to a uniform line doublet at point O of strength μ per unit length if its axis is along the x- axis. 7 marks

c) A lubricating oil of viscosity 1 poise and specific gravity 0.9 is pumped through a 30mm diameter pipe, if the pressure drop per metre length of pipe is 20KN/m^2. Determine

i) The mass flow rate in kg/min. 4 marks

ii) Shear stress at the pipe wall. 2 marks

iii) The Reynolds number for the flow. 2 marks

d) Show whether the function $\psi = A\left(x^2 - y^2\right)$ represents a possible irrotational flow. 3 marks

Question FIVE (20 marks)

a) The velocity distribution in a pipe is given by $\frac{U}{U\max} = 1-\left(\frac{r}{R}\right)^n$ where U_{max} is the maximum velocity at the centre of a pipe, U is the velocity at a distance r from the centre and R is the pipe radius. Obtain an expression for mean velocity in terms of U_{max} and n. 5 marks

b) The flow field of a fluid is given by $V = xyi + 2yzj - \left(yz + z^2\right)k$:

i) Show that it represents a possible 3 dimensional steady incompressible continuous flow. 2 marks

ii) Is this flow rotational or irrotational. 2 marks

iii) If irrotational determine at point A (2, 4, 6) the value of angular velocity and vorticity. 4 marks

b) If there is a line source of strength m at a point Z and a line source of equal strength at the mirror image of z_1 at the line x=0. Prove that there is no fluid motion across the mirror x=0. 7 marks

THE END