MACHAKOS UNIVERSITY COLLEGE

(A Constituent College of Kenyatta University)
University Examinations for 2015/2016 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

FIRST SEMESTER EXAMINATION FOR DEGREE IN
BACHELOR OF EDUCATION (SCIENCE)
BACHELOR OF EDUCATION (ARTS)
BACHELOR OF EDUCATION

SMA 334: FLUID MECHANICS II

DATE: 1/8/2016 **TIME: 11:00 – 1:00 PM**

INSTRUCTIONS:

Answer QUESTION ONE and Any other TWO Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Define the following terms
   i) a streamline (1 mark)
   ii) compressible and incompressible flows (1 mark)
   iii) irrotational flow (1 mark)

b) Distinguish between a source, sink and a doublet in a two dimensional flow. (6 marks)

c) Determine the stream function ψ given $\phi = 3xy^2 - x^3$ (4 marks)

d) Show that velocity potential ϕ and stream function ψ satisfy the Laplace's equation for a two dimensional flow. (6 marks)

e) State the Blassius theorem. (2 marks)

f) Derive the polar form of the Cauchy –Riemann equations. (5 marks)

g) Given the velocity field $\mathbf{q} = 6\mathbf{i} + 8\mathbf{j} - 10\mathbf{k}$,

i) Show that the flow is irrotational

ii) Find the velocity potential ϕ (4 marks)

QUESTION TWO (20 MARKS)

a) What arrangement of sources and sinks will give rise to the function $\omega = \log\left(z - \frac{1}{z}\right)$.

Draw a rough sketch of the streamlines. (10 marks)

b) Derive the equation of energy with constant viscosity and heat conductivity of fluid. (10 marks)

QUESTION THREE (20MARKS)

a) Show that given the complex potential ω, we can find the

i) Velocity potential ϕ (2 marks)

ii) Stream function ψ (2 marks)

iii) Equations of the streamlines (2 marks)

iv) Stagnation points (2 marks)

v) Speed. (2 marks)

b) Discuss a two dimensional motion where there is a source of strength m at $(0,0)$ and equal sinks at $(2,0)$ and $(-2,0)$. Draw also the streamlines. (10 marks)

QUESTION FOUR (20MARKS)

a) Derive the equations of the conservation of momentum . (10 marks)

b) Write Navier –Stokes equations in Cartesian co-ordinates.

Simplify the equations when

i) Fluid is incompressible and dynamic viscosity is constant

ii) The fluid is incompressible and viscous effects are neglible (10 marks)

QUESTION FIVE (20MARKS)

a) Given the Laplace's equation $\nabla^2\phi = 0$, convert it in to Polar coordinates. (10 marks)

b) Prove the Blassius theorem. (10 marks)