



MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN MATHEMATICS

BACHELOR OF EDUCATION (SCIENCE)

SMA 334: FLUID MECHANICS II

DATE: 13/12/2017

TIME: 2:00 – 4:00 PM

INSTRUCTION:

Answer Questions One and Any Other Two.

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Define the following terms
 - i) Equipotential lines (2 marks)
 - ii) Streamlines (2 marks)
- b) State the Blasius's theorem. (2 marks)
- c) Distinguish between the steady and unsteady flow (4 marks)
- d) State the method of images (2 marks)
- e) An electrostatic field in the xy -plane is given by the potential function $\phi = 3x^2y - y^3$. Find the stream function. (5 marks)
- f) The stream function of a flow is $\phi = 2xy$. sketch the streamlines and determine the velocity at $(0,0)$ and $(5,0)$ (5marks)
- g) Derive the Cauchy-Riemann equation in regard to the velocity potential and stream function for a two dimensional irrotational flow in polar form. (5 marks)

QUESTION TWO (20 MARKS)

- a) If $w = \phi + i\psi$ represents the complex potential for an electric field and

$$\phi = x^2 - y^2 + \frac{x}{x^2 + y^2}, \text{ determine the function } \psi. \quad (8 \text{ marks})$$

- b) What arrangement of sources and sinks will give rise to the function $w = \log\left(\frac{a^2}{z} - z\right)$.

Draw a rough sketch of the streamlines. (12 marks)

QUESTION THREE (20MARKS)

- a) For a two dimensional , incompressible , irrotational flow formed from superposition of a doublet and a uniform flow, find
- i) The stream function and velocity potential
 - ii) Velocity field
 - iii) Stagnation points
 - iv) Cylinder surface
 - v) Surface pressure distribution
 - vi) Drag force on the circular cylinder
 - vii) Lift force on the circular cylinder. (13 marks)
- b) Derive the Navier Stokes equations in Cartesian coordinates when the fluid is incompressible and the dynamic viscosity is constant. (7 marks)

QUESTION FOUR (20MARKS)

For a two dimensional flow the velocity function is given by the expression $\phi = x^2 - y^2$

- i) Determine the velocity components in x and y directions
- ii) Show that the velocity components satisfy the conditions of flow continuity and irrotationality
- iii) Determine the stream function and the flow rate between the stream lines $(2,0)$ and $(2,2)$
- iv) Show that the streamlines and potential lines intersect orthogonally at the point $(2,2)$ (20 marks)

QUESTION FIVE (20MARKS)

- a) Prove that if the mapping $w = f(z)$ is conformal then the function $f(z)$ is an analytic function of z (10 marks)
- b) Determine the image of a source of strength m at a point A with respect to the circle with center at O . (10 marks)