

BOWEN UNIVERSITY, IWO, NIGERIA
FACULTY OF SCIENCE AND SCIENCE EDUCATION
DEPARTMENT OF MATHEMATICS AND STATISTICS
B.Sc DEGREE 2014/2015 FIRST SEMESTER EXAMINATION

COURSE CODE: MAT 317

COURSE TITLE: HYDROMECHANICS

DATE: 25/01/2015 TIME ALLOWED: 2½ HOURS CREDITS: 3

INSTRUCTION: Attempt any four questions.

1. Derive the equation of continuity for an incompressible fluid in terms of rectangular cartesian coordinates. The velocity components of an incompressible fluid flow at (x, y, z) at time t are given by $u = y - ct$, $v = x - ct$, $w = 0$ where c is a constant. Verify that the equation of continuity is satisfied.
2. Derive the equation of motion of a fluid of density ρ subject to a body force \underline{F} per unit mass and pressure p in the form

$$\rho \frac{dq}{dt} + \nabla p - \rho \underline{F} = 0$$

3. Show that

$$u = \frac{-2xy}{(x^2 + y^2)^2}, \quad v = \frac{(x^2 - y^2)z}{(x^2 + y^2)^2}, \quad w = \frac{y}{x^2 + y^2}$$

are the velocity components of a possible fluid motion. Is this motion irrotational?

4. Explain the meaning of the term "stream function". Obtain the stream functions for
 - (i) a simple source and a sink of strength m at a distance $2b$ apart.
 - (ii) A doublet of strength μ at the origin making angle α to the x - axis.
5. Prove that the variable ellipsoid

$$\frac{x^4}{a^2 \lambda^2 t^4} + \lambda t^2 \left(\frac{y^2}{b^2} + \frac{z^2}{c^2} \right) = 0$$

is a possible form of boundary surface of a liquid at time t .