THE OPEN UNIVERSITY OF SRI LANKA
B.Sc./B.Ed DEGREE PROGRAMME-LEVEL 05
OPEN BOOK TEST-2023/2024
ADU5306 — FLUID MECHANICS
DURATION: ONE HOUR

Date: 24. 12. 2023 **Time: 2.30 p.m. –3.30 p.m.**

ANSWER ALL QUESTIONS.

1. a). Derive the continuity equation of the form $\frac{D\rho}{Dt} + \rho\, div\left(\underline{\boldsymbol{q}}\right) = 0$, for any arbitrary control volume of a moving fluid irrespective of its shape and size. $\underline{\boldsymbol{q}}$ and ρ are fluid velocity and fluid density respectively.

   b). Hence deduce the continuity equation for incompressible fluid in terms of Cartesian Coordinates.

2. a). Write down the continuity equation for an incompressible fluid in terms of spherical polar coordinates (r, θ, ω).

   Fluid velocity at a point having spherical polar coordinates (r, θ, ω) has components given by $\underline{\boldsymbol{q}} = \left[\frac{2\mu cos\theta}{r^3}, \frac{\mu\, sin\theta}{r^3}, 0\right]$ where μ is a constant.

   b). Show that this represents a possible motion of an incompressible fluid and find the equations of streamlines.

   c). Verify that the motion is irrotational.

3. a). Derive the Euler's equation of motion for a perfect fluid of the form $\underline{F} - \frac{1}{\rho}\, grad\, p = \frac{D\underline{\boldsymbol{q}}}{Dt}$.

   b). Hence show that the above equation can be written in the form.

   $\underline{F} - \frac{1}{\rho}\, grad\, p = \frac{\partial \underline{\boldsymbol{q}}}{\partial t} + grad\left(\frac{q^2}{2}\right) - \underline{\boldsymbol{q}} \times curl\, \underline{\boldsymbol{q}}$.