THE AMERICAN COLLEGE, MADURAI

(An Autonomous Institution Affiliated to Madurai Kamaraj University)

Re-accredited (2nd Cycle) by NAAC with Grade "A", CGPA – 3.46 on a 4-point scale

Backlog Arrear Examination, March 2021

PGM 4232 **FLUID DYNAMICS** **75 Marks**

Answer any FIVE Questions **5 X 15 = 75**

1. (a) Derive equation of continuity. Also derive equation of continuity for a variable cross section.

   (b) Establish the relation $\tau = 2\omega$, connecting the angular velocity ω, and the vorticity vector τ.

2. . State and Prove Euler's equation of motion. Deduce Bernoulli's equation. Also derive Bernoulli's equation for potential flows under conservative body forces.

3. Show that for a motion of an inviscid incompressible fluid of uniform density, under gravity, the vorticity ω satisfies the equation $\frac{\partial \omega}{\partial t} + (\mathbf{v}.\nabla)\omega = (\omega.\nabla)\mathbf{v}$, where **v**(x,y.z,t) is the velocity. Also explain the significance of each term in this equation. A motion, symmetric about the axis z=0, is described in terms of cylindrical polar coordinates (r,θ,z), the velocity having components $v_r(r,z), v_\theta = 0, v_z(r,z)$. By evaluating the term $(\omega.\nabla)v$,or otherwise, show that if the fluid element has vorticity ω_0, when at radius r_0, its vorticity ω at radius r is given by $r_0\omega = r\omega_0$.

4. . (a) An incompressible fluid with density ρ is contained within the region bounded by teo concentric rigid spherical surfaces of radii R_1, R_2 $(R_2 > R_1)$ and the fluid is initially at rest. If the inner surface is given a sudden velocity U**i**, where **i** is the constant unit vector derive the impulsive thrust on the outer surface.

   (b) State and Prove Kelvin's theorem.

5. State and Prove Weiss's sphere theorem.Also discuss about the image of a doublet in a sphere when the axis of the doublet passes through the centre of the sphere.

6. State and Prove the Theorem of Blasius. For an infinite circular cylinder in uniform stream, with circulation , find the components of the force and the moment.

7. State and Prove Milne-Thomson Circle Theorem. Discuss the complex velocity potential when the circular cylinder of section 1z1=a due to the line doublet parallel to the axis of a right circular cylinder

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