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M.A./M.Sc. (Final) Main Examination, 2022

MATHEMATICS

(Fluid Mechanics)

[Paper : Sixth (Optional)]

Time Allowed : Three Hours

Maximum Marks : 100

Minimum Passing Marks : 36

Note : Attempt **any five** questions. All questions carry **equal** marks.

1. Explain streamline, pathlines and streaklines.
2. Show that the necessary and sufficient condition such that the vortex lines are at right angles to the stream lines, is

$$(u, v, w) = \mu \left(\frac{\partial \phi}{\partial x}, \frac{\partial \phi}{\partial y}, \frac{\partial \phi}{\partial z} \right)$$

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[P.T.O.]

i.e. $\bar{q} = \mu \nabla \phi$, where μ and ϕ are functions of x, y, z and t .

3. Derive the components of acceleration in cylindrical co-ordinate (r, θ, z) .
4. An Infinite mass of ideal incompressible fluid is subjected to a force $\mu r^{-7/3}$ per unit mass directed towards the origin. If initially the fluid is at rest and there is a cavity in the form of sphere $r = a$ in it, show that the cavity will be completely filled after an interval of time $\pi a^{5/3} (10\mu)^{-1/2}$.
5. State and prove Kelvin's Minimum Energy Theorem.
6. Define Doublet. Find the velocity potential of the doublet.
7. Discuss the uniform flow past an infinitely long circular cylinder.
8. State and prove Blasius theorem.
9. If n rectilinear vortices of the same strength k are symmetrically arranged along generators of a circular cylinder of radius ' a ' in an infinite liquid, prove that the

vortices will move round the cylinder uniformly in time

$\frac{4\pi a^2}{k(n-1)}$. Also find the velocity at any point of the fluid.

10. Derive equation of motion of a gas.

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