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PGIIIS-N 1531 B-2K13

M.A./M.Sc. IIIrd Semester (CBCS) Degree Examination

Mathematics

(Fluid Mechanics-I)

Paper - SCT-3.1

(New)

Time : 3 Hours Maximum Marks :80

Instructions to Candidates:

i) Answer any **five** questions

ii) All questions Carry **equal** marks.

1. a) Explain about Lagrange and Euler's method in Fluid motion. Derive $\frac{\partial \varrho}{\partial t}+\nabla\left(\varrho \vec{g}\right)=0$ **(8)**

   b) Find the path lines and streak lines for the velocity $\vec{q}=\left(\frac{x}{t}, y, 0\right)$. **(8)**

2. a) Derive Lamb's Hydrodynamical equation. **(8)**

   b) Show that the difference of the values of stream function at the two points represents the flux of a fluid across any curve joining the two points. **(8)**

3. a) Define sources, sinks. Find the complex potential for a doublet. **(8)**

   b) Derive the complex potential for the image of a doublet relative to a circle. Define confirmal transformation. **(8)**

4. a) Fluid is coming out from a small hole of cross-section σ_1 in a tank, if the minimum cross-section of the stream coming out of the hole is σ_2, then show that $\frac{\sigma_2}{\sigma_1}=\frac{1}{2}$ **(8)**

   b) Prove that for liquid circulating irrotationally in part of the plane between two non-intersecting circles, the curves of constant velocity are Cassini's ovals. **(8)**

5. a) Discuss the motion of a circular cylinder moving with velocity U along x-axis in an infinite mass of liquid at rest at infinity. **(8)**

b) State and prove Blasius theorem. **(8)**

6. a) A circular cylinder is fixed across stream of velocity U with circulation K around the cylinder. Show that the maximum velocity in the liquid is $2U + \frac{K}{2\pi a}$, where a is the radius of the cylinder. **(8)**

b) Show that the velocity potential of sphere is $\phi = \left[Ar^n + Br^{-(n+1)} \right] P_n(\mu)$ where $\mu = \cos\theta$ and (r, θ, ω) are the spherical co-ordinates. **(8)**

7. a) Liquid is contained in a rotating elliptic cylinder. By making use of elliptic transformation $Z = C\cosh and$, show that the stream function of the motion is $\psi = \frac{1}{2}\omega\left(\frac{a^2 - b^2}{a^2 + b^2}\right)\left(x^2 - y^2\right)$. **(8)**

b) Show that when an infinitely long cylinder of density σ whose cross section is ellipse of semi axes a; b is immersed in an infinite liquid of density ϱ, the square of its radius of gyration about its axis is effectively increased by the quantity $\frac{\varrho}{8\sigma}\frac{\left(a^2 - b^2\right)^2}{ab}$ **(8)**

8. a) Find the necessary and sufficient condition that vortex lines may be at right angles to the stream lines. **(8)**

b) Derive vorticity transport equation. **(8)**
