APRIL/MAY 2019

MMA35C — FLUID DYNAMICS

Time : Three hours Maximum : 75 marks

SECTION A — ($5 \times 6 = 30$ marks)

Answer ALL questions.

1. (a) Obtain the conditions at a rigid boundary.

Or

(b) For a fluid moving in a fine tube of variable section A, prove from the first principles that the equation of continuity is $A\frac{\partial p}{\partial t}+\frac{\partial}{\partial x}(A\rho v)=0$, where v is the speed at a point p of the fluid and s the length of the tube up to p. What does this become for steady incompressible flow?

2. (a) Write down the venturi tube problem and solve it.

Or

(b) Derive the Bernoulli's equation.

3. (a) Explain about sources, sinks and doublets.

Or

(b) Obtain the Stoke's stream function.

4. (a) Derive the live doublets.

Or

(b) Find the equations of the stream lines due to uniform line sources of strength on through the points $A(-c,0), B(c,0)$ and a uniform like sink of strength 2m through the origin.

5. (a) Obtain the coefficient of viscosity and laminar flow.

Or

(b) Derive the translational motion of fluid element.

SECTION B — (3 × 15 = 45 marks)

Answer any THREE questions.

6. Test whether the motion specified by $q = \dfrac{K^2(xj - yi)}{x^2 + y^2}$ $(K = constant)$ is a possible motion for an incompressible fluid. If so, determine the equations of the streamlines. Also test whether the motion is of the potential kind and if so determine the velocity potential.

7. Derive the Euler's equation of motion.

8. Doublets of strengths μ_1, μ_2 are situated at points A_1, A_2 whose Cartesian co-ordinates are $(0,0,C_1), (0,0,C_2)$ their axes being directed towards and away from the origin respectively. Find the condition that there is no transport of fluid over the surface of the sphere $x^2 + y^2 z^2 = c_1 c_2$.

9. A cylinder of infinite length and nearly circular section moves through an infinite volume of liquid with a velocity u at right-angles to its axis and in the direction of the x-axis. If its section is specified by the equation $R = a(1 + \varepsilon \cos n\theta)$, where ε is small, show that the approximate value of the velocity potential is

$$Ua\left\{\frac{a}{R}\cos\theta + \varepsilon\left(\frac{a}{R}\right)^{n+1} \cos(n+1)\theta - \varepsilon\left(\frac{a}{R}\right)^{n-1} \cos(n-1)\theta\right\}$$

10. Obtain the relation between Cartesian components of stress.

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