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60582

B.Sc. 6th Semester Examination, July-2021

MATHEMATICS (HONS)

Paper-BHM-365

(Fluid Dynamics)

Time : **Three Hours**]

[**Maximum Marks : 60**

Before answering the questions, candidates should ensure that they have been supplied the correct and complete question paper. No complaint in this regard, will be entertained after examination.

Note :- Attempt *five* questions in all, selecting *one* question from each Section. Q. No. 9 is compulsory. All questions carry equal marks.

Section-I

1. (a) The velocities at a point in a fluid in the Eulerian system are given by $u = x + y + z + t$, $v = 2(x + y + z) + t$, $w = 3(x + y + z) + t$, obtain the displacements of a fluid particle in the Lagrangian system.

- (b) The velocity field at a point in fluid is given by $\vec{q} = \left(\frac{x}{1+t}, y, 0 \right)$. Find the streamlines, pathlines and streaklines.

2. (a) Derive equation of continuity in cylindrical co-ordinates.

- (b) Show that :

$$u = \frac{-2xyz}{(x^2 + y^2)^2}, v = \frac{(x^2 - y^2)z}{(x^2 + y^2)^2}, w = \frac{y}{x^2 + y^2}$$

are the possible velocity components of a liquid motion. Is this motion irrotational?

Section-II

3. (a) Components of acceleration in spherical polar co-ordinates (r, θ, ϕ) with velocity components (V_r, V_θ, V_ϕ) .

(b) Homogeneous liquid is in motion in a vertical plane, within a curved tube of uniform small bore, under the action of gravity. Calculate period of oscillation.

4. ~~(a)~~ Obtain Bernoulli's equation for steady motion.
~~(b)~~ In a two dimensional incompressible flow, the fluid velocity components are given by $u = x - 4y$ and $v = -y - 4x$. Show that velocity potential exists and determine its form as well as stream function.

Section-III

5. (a) State and prove Kelvin's minimum energy theorem.
 (b) Show that there cannot be two different forms of irrotational motion for a given confined mass of incompressible inviscid liquid whose boundaries are subject to the given impulses. <https://www.mdustudy.com>
6. (a) Determine velocity potential due to a three dimensional doublet.
 (b) Discuss motion of a sphere through an infinite mass of a liquid at rest at infinity.

Section-IV

7. ~~(a)~~ The velocity potential function for a two dimensional flow is $\phi = x(2y - 1)$. At a point $p(4, 5)$ determine :
 (i) The velocity stream
 (ii) The value of function

~~(b)~~ State and prove Milne-Thomson circle theorem.

8. ~~(a)~~ Find the image of a line doublet in a circle.

~~(b)~~ An infinite cylinder of radius a and density σ is surrounded by a fixed concentric cylinder of radius b and the intervening space is filled with liquid of density ρ . Prove that the impulse per unit length necessary to start the inner cylinder with velocity V is :

$$\frac{\pi^2}{b^2 - a^2} [(\sigma + \rho)b^2 - (\sigma - \rho)a^2] V$$

Section-V

9. (a) Write short note on sinks and doublets.
 (b) Give examples of irrotational and rotational flows.
 (c) Define Lagrange's stream function.
 (d) Define term-impulsive motion.
 (e) Discuss significance of the equation of continuity.
 (f) State Blasius theorem.