Roll No. .....

(01/21-I)

11667

M. Sc. (2 Years) EXAMINATION

(For Batch 2018 & Onwards)

(Third Semester)

MATHEMATICS

MTHCC-2302

Fluid Mechanics

Time : Three Hours *Maximum Marks :* 70

Note : Attempt *Five* questions in all, selecting *one* question from each Unit. Q. No. **1** is compulsory. All questions carry equal marks.

1. (i) Explain Lagrangian method of describing fluid motion.

   (ii) Give the distinction between path lines and stream lines.

   (iii) Describe vorticity equation.

(iv) Describe the concept of images for three-dimensional flow.

(v) Explain stream function for an axi-symmetric flow.

(vi) Describe two-dimensional motion of a fluid.

(vii) Show that the stream function for a two-dimensional motion satisfies the Laplace's equation. 2×7=14

Unit I

2. (a) Show that the motion specified by $\vec{q} = \frac{A\left(x\hat{i} - y\hat{j}\right)}{x^2 + y^2}$, (A is a constant) is a possible motion for an incompressible fluid. So, determine the equations of the streamlines. 7

(b) Find the pathlines and the streaklines, when the velocity field at a point in fluid is given as $\vec{q} = \left(\frac{x}{t}, y, 0\right)$. 7

3. (a) Derive the equation of continuity for fluid motion. 7

(b) Find the condition for the surface $F(\vec{r}, t) = 0$ or $F(x, y, z, t) = 0$ to be a boundary surface. 7

Unit II

4. (a) Derive the Euler's equation of motion for an ideal fluid. 7

(b) Discuss the flow of fluid out of a large tank of radius 'A' through a small hole of radius 'a' located in the bottom of a tank. 7

5. (a) State and prove Kelvin's minimum energy theorem. 7

(b) Derive the vorticity equation for the flow of an ideal fluid in the presence of conservative and non-conservative body forces. 7

Unit III

6. (a) Describe two-dimensional motion of a fluid and hence find its most general solution. 7

(b) For a frictionless liquid streaming past a fixed sphere, obtain the lines of flow relative to the sphere. 7

7. (a) Find the velocity potential due to a simple source of strength 'm' in an incompressible fluid. 6

(b) Find the image of a source with respect to a sphere. 8

Unit IV

8. (a) Show that the difference in the values of stream function taken on two streamlines measures the volume of fluid which flows between these two streamlines per unit depth in unit time. 7

(b) Define complex potential and discuss the flow for which the complex potential is $w = z^2$. 7

9. (a) Give the Stoke stream function for a simple source at origin. 4

(b) State and prove Blasius theorem. 10