motion for an incompressible fluid. So, determine the equations of the streamlines. Also, show that the motion is of potential kind and hence find the velocity potential. **12**

Or

If the lines of motion are curves on the surfaces of cones having their vertices at the origin and the axis of z as common axis. Prove that the equation of continuity is : **12**

$$\frac{\partial \rho}{\partial t}+\frac{\partial}{\partial t}(\rho q_r)+\frac{2\rho q_r}{r}+\frac{\operatorname{cosec}\theta}{r}\frac{\partial}{\partial w}(\rho q_w)=0$$

12. Describe the complete motion of a sphere in a fluid at rest at infinity. **12**

Or

(a) State and prove Kelvin's minimum energy theorem. **8**

(b) Show that acyclic irrotational motion is impossible in a finite fluid domain bounded by rigid surfaces at rest. **4**

Subject Code—0359

M. Sc. EXAMINATION

(Batch 2011 Onwards)

(Third Semester)

MATHEMATICS

MAL-634

Fluid Mechanics

Time : 3 *Hours* *Maximum Marks :* 70

Section A

Note : Attempt any *Seven* questions. **7×5=35**

1. Describe in detail two different view points to discuss the problems of fluid motion. **5**

2. Find the pathlines and the streaklines, when the velocity field at a point in fluid is

given as : **5**

$$\vec{q} = \left(\frac{x}{t}, y, 0 \right)$$

3. Derive the Euler's equation of motion for an ideal fluid. **5**

4. Derive the Bernoulli's equation for the steady flow of an ideal fluid with conservative body forces. **5**

5. Show that the kinetic energy of the moving fluid of an infinite liquid in irrotational motion, which is considered to be at rest at infinity and is bounded internally by solid surfaces s_1, s_2, ..., s_n is $T = \frac{1}{2}\rho \int \phi \frac{\partial \rho}{\partial n} ds$, where ϕ is the velocity potential, ρ is the uniform density and the normal to the surfaces is drawn outward to the fluid. **5**

6. Describe the motion of a uniform stream with a simple source in the fluid.

7. Find the motion of a circular cylinder moving in an infinite mass of the liquid at rest at infinity, with velocity U in the direction of x-axis. **5**

8. 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. **5**

9. Describe the image of a three dimensional doublet in a rigid infinite plane. **5**

10. Find the Stoke's stream function for the following :

(i) Uniform stream

(ii) Simple source at origin. **5**

Section B

Note : Attempt all the questions.

11. 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

13. Define rectilinear vortices. Derive velocity potential, stream function and complex potential due to a rectilinear vortex filament.

Or

State and prove Milne-Thomson circle theorem. Hence describe the uniform flow past a stationary cylinder. **11**

13. Define rectilinear vortices. Derive velocity potential, stream function and complex potential due to a rectilinear vortex filament.

Or

State and prove Milne-Thomson circle theorem. Hence describe the uniform flow past a stationary cylinder. **11**