(Third Semester)

Branch – **MATHEMATICS**

INCOMPRESSIBLE FLOW

Time: Three Hours Maximum: 75 Marks

Answer **ALL** questions

ALL questions carry **EQUAL** marks

1. a) Derive Euler's equation of motion for an ideal incompressible fluid. (8)

   b) Derive the equation of motion for a steady, inviscid, incompressible fluid. (7)

   OR

   c) Show how the Navier-Stokes equation is derived from the basic principles of conservation of momentum. (7)

   d) Explain the physical significance of Euler's Momentum Theorem. (8)

2. a) Explain the significance of the initial and boundary conditions in ensuring the uniqueness of the solution to the equation of motion. (8)

   b) Explain the advantages of using the stream function to analyze two-dimensional flows. (7)

   OR

   c) Define the indirect approach in the context of two-dimensional fluid flow and contrast it with the direct approach. (4)

   d) What is the complex potential in two-dimensional fluid flow, and how is it related to the velocity potential? (4)

   e) Describes the flow pattern around a point source or sink, where Q is the source strength and θ is the tangential velocity component. (7)

3. a) Transforms the flow field of a source into n equal parts, creating multiple sources or Sinks depending on n. (8)

   b) State and prove Blasius theorem. (7)

   OR

   c) Define irrotational flow in three dimensions. How does it differ from rotational flow? (8)

   d) What are the boundary conditions for solving Laplace's equation in three- dimensional irrotational flow around a body? (7)

4. a) Discuss the difference between Newtonian and non-Newtonian fluids with respect to viscosity behavior. (8)

   b) Explain the difference between steady and unsteady solutions of the Navier-Stokes equations with examples. (7)

   OR

   c) What is the significance of the laminar flow solution in the context of Navier-Stokes equations? (8)

   d) Explain the concept of vertex density in irrotational motion within a three- dimensional flow. (7)

5. a) Explain the physical significance of the boundary layer in fluid flow along a plane wall. (7)

   b) What are typical values of boundary layer characteristics for different flow regimes? (8)

   OR

   c) Derive an expression for the displacement thickness using the integral boundary layer equations. (8)

   d) Derive the Blasius equation for laminar flow over a flat plate and explain its physical significance. (7)

Z-Z-Z END