Fluid Flow Problems - Question Statements

1. Flow Past a Rankine Oval

Question: Given the complex potential:

$$F(z) = Uz + \frac{m}{2\pi}\ln(z+c) + \frac{m}{2\pi}\ln(z-c)$$

where:

- U: Uniform flow velocity.
- m: Source strength.
- c: Distance of the sources from the center.

Analyze the flow past a Rankine oval:

1. Compute the velocity potential (ϕ) and stream function (ψ) at various points.
2. Visualize the flow patterns using streamlines (ψ).

2. Flow in a Corner (Stagnation Point Flow)

Question: The complex potential for a stagnation point flow is:

$$F(z) = \frac{A}{2}z^2$$

where A is a constant representing the stagnation flow strength.

1. Compute the velocity potential (ϕ) and stream function (ψ) at points in the flow field.
2. Plot the streamlines (ψ) and equipotential lines (ϕ).

3. Combined Source and Uniform Flow

Question: The complex potential for a combined uniform flow and source is:

$$F(z) = Uz + \frac{m}{2\pi}\ln(z)$$

where:

- U: Uniform flow velocity.
- m: Source strength.

1. Determine the velocity potential (ϕ) and stream function (ψ).
2. Identify the stagnation points in the flow.
3. Plot the streamlines (ψ).

4. Flow Around Two Circular Cylinders

Question: The complex potential for flow around two circular cylinders is:

$$F(z) = U\left(z + \frac{a_1^2}{z}\right) + U\left(z - d + \frac{a_2^2}{z-d}\right)$$

where:

- U: Uniform flow velocity.
- a_1, a_2: Radii of the two cylinders.
- d: Distance between the centers of the cylinders.

1. Compute the velocity potential (ϕ) and stream function (ψ).
2. Visualize the flow patterns around the two cylinders by plotting the streamlines (ψ).

5. Flow with Vortex Around a Cylinder

Question: The complex potential for a uniform flow with a vortex around a cylinder is:

$$F(z) = Uz + \frac{a^2 U}{z} + i\frac{\Gamma}{2\pi}\ln(z)$$

where:

- U: Uniform flow velocity.
- a: Radius of the cylinder.
- Γ: Circulation strength of the vortex.

1. Calculate the velocity potential (ϕ) and stream function (ψ).
2. Plot the streamlines (ψ) to visualize the effect of the vortex.
3. Identify the lifting characteristics caused by the vortex.