Vorticity – Stream function approach:

Vorticity in 2D case: $\omega = |\vec{\omega}| = |\nabla \times \vec{u}| = \frac{\partial u_y}{\partial x} - \frac{\partial u_x}{\partial y}$

and stream-function: $\frac{\partial \psi}{\partial y} = u_x$, $\frac{\partial \psi}{\partial x} = -u_y$

We obtain, non-pressure vorticity transport eqⁿ, which in non-steady form can be written as →

$$\frac{\partial \omega}{\partial t} + u_x \frac{\partial \omega}{\partial x} + u_y \frac{\partial \omega}{\partial y} = Re^{-1} \nabla^2 \omega$$

and combining all vorticity & stream-function eqⁿ, we obtain poisson eqⁿ for the ψ variable –

$$\nabla^2 \psi = -\omega$$

Algorithm to solve VS function is simpler than the SIMPLE method. It can be shown as ⇒

Step-1: Set initial ω, ψ

if not converged →
- Step-2: Solve vorticity transport eqⁿ
- Step-3: Solve poisson eqⁿ for ψ

if converged →
- Step-4: Obtain u_x, u_y
- Step-5: Visualize results.