

# Project Report

Submitted by

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## Problem:

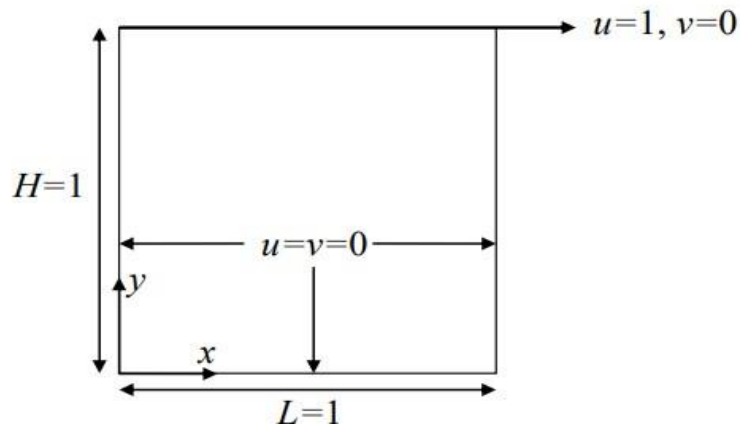
Solve the following partial differential equation using the finite difference method with the specified boundary conditions for the geometry with **100×100** grid size as shown in the figure.

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = -\omega$$

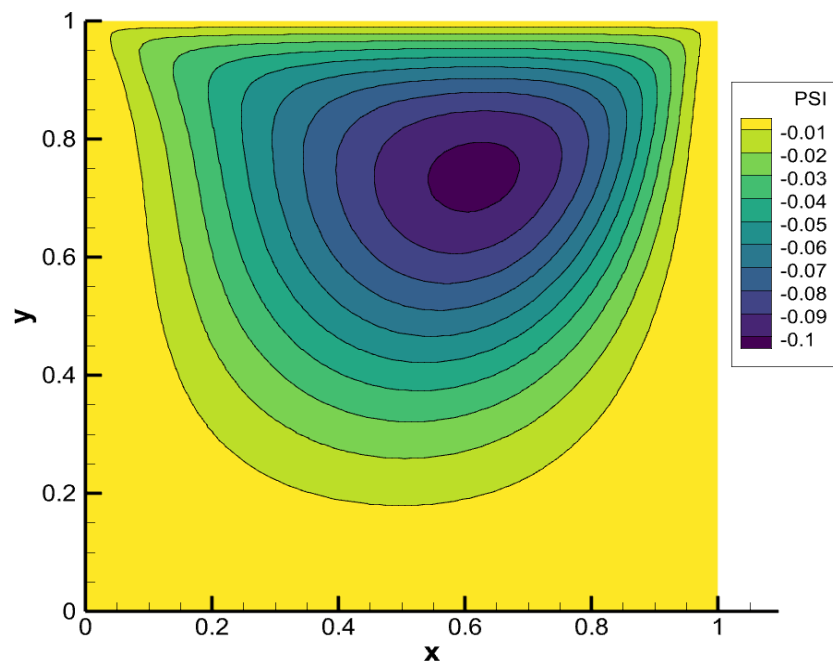
$$u \frac{\partial \omega}{\partial x} + v \frac{\partial \omega}{\partial y} = \frac{1}{\text{Re}} \left( \frac{\partial^2 \omega}{\partial x^2} + \frac{\partial^2 \omega}{\partial y^2} \right)$$

$$u = \frac{\partial \psi}{\partial y}, \quad v = -\frac{\partial \psi}{\partial x}$$

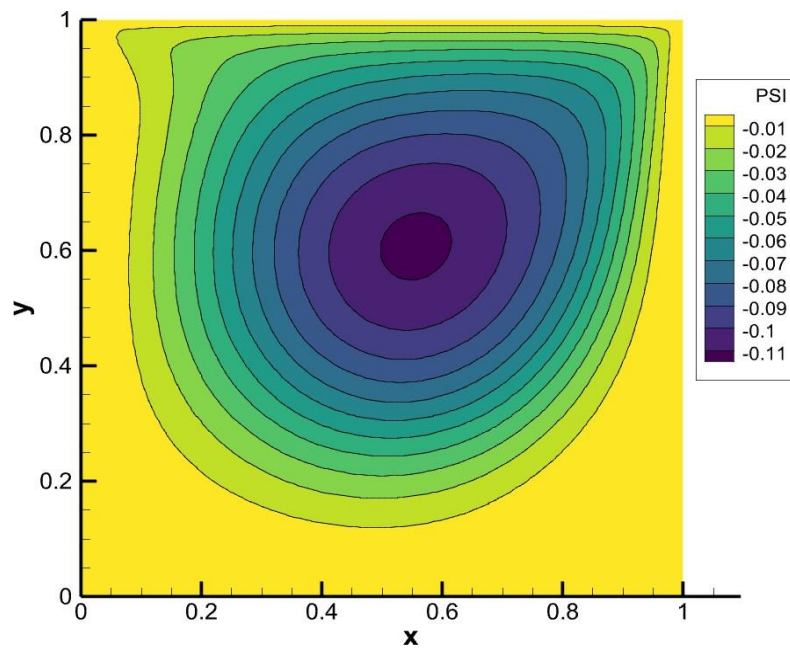
**Convergence Criteria:** Find the maximum error of stream function and vorticity and reduce that maximum error to  $10^{-6}$ . Apply the finite difference discretization to replace all derivatives with the corresponding central difference expressions with uniform grid  $M \times N$  and *write the discretized equations of the governing equations and boundary conditions of stream function & vorticity in the report*. Write the code in such a way so that you can input the values of  $\text{Re}, M, N$ . Submit the results and discussion for **Re=100 and 400** in terms of streamlines, velocity vectors,  $u$  velocity along vertical centerline and  $v$  velocity along horizontal centerline.



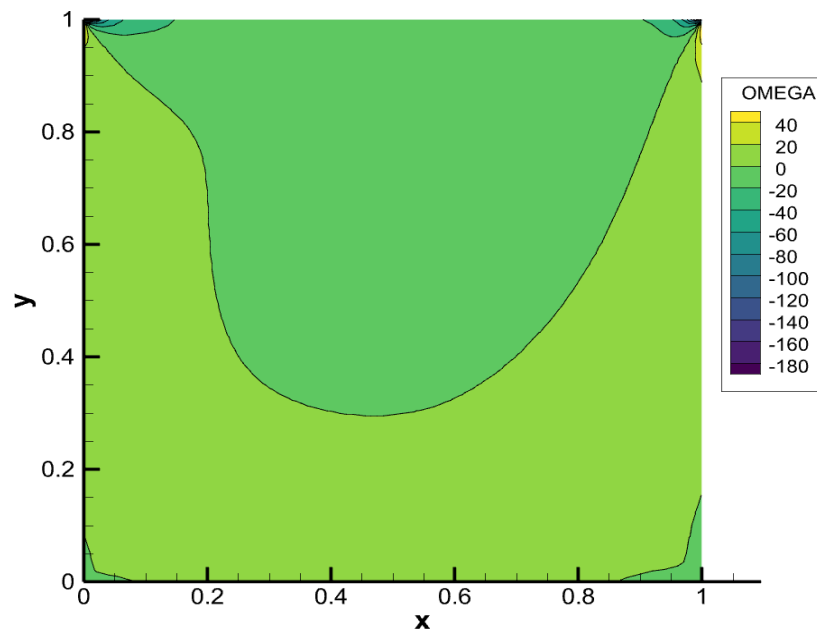
Re = 100 ; Grid Size = 100 × 100 ; Stream Line Graph



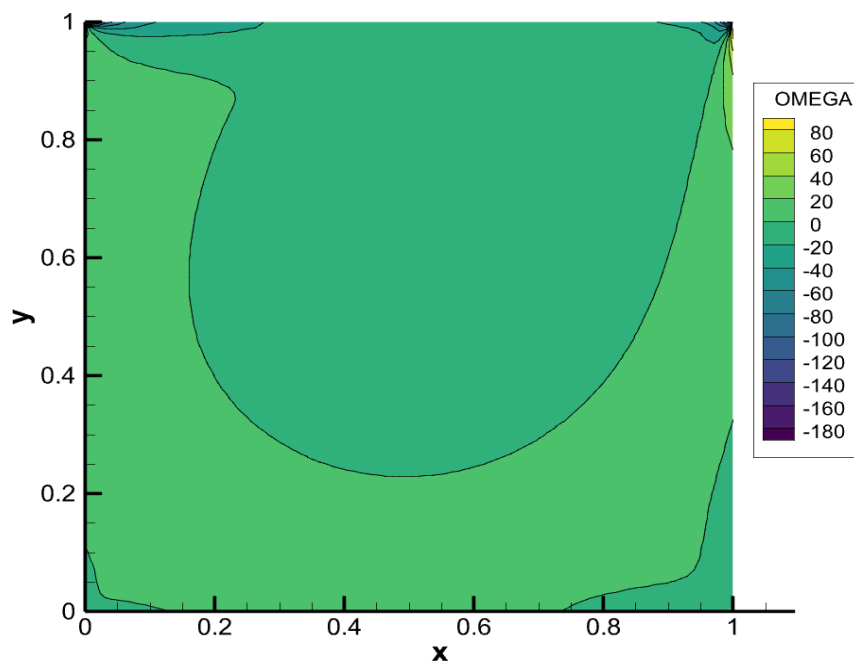
Re = 400 ; Grid Size = 100 × 100 ; Stream Line Graph



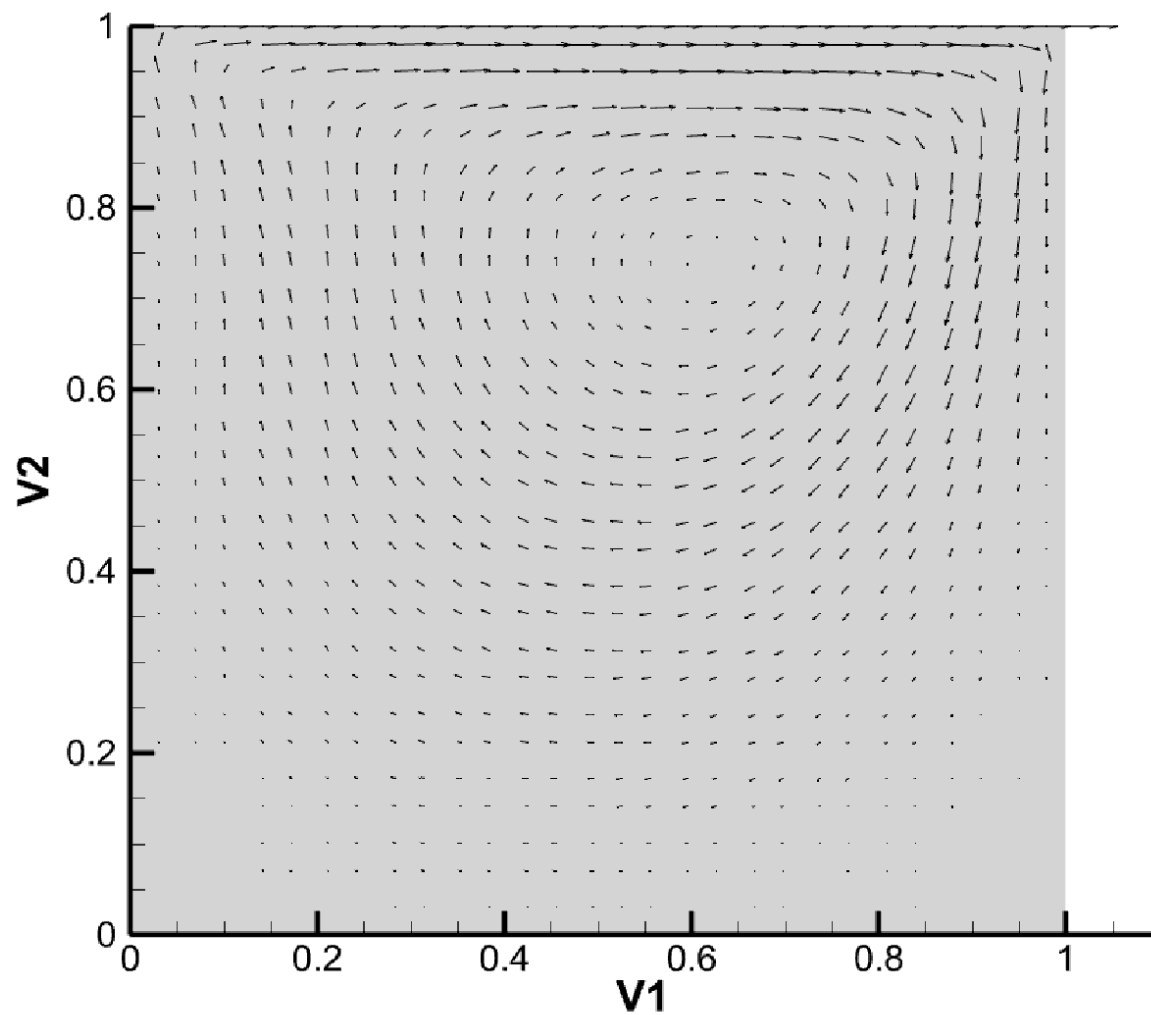
Re = 100 ; Grid Size = 100 × 100 ; Vorticity (omega)



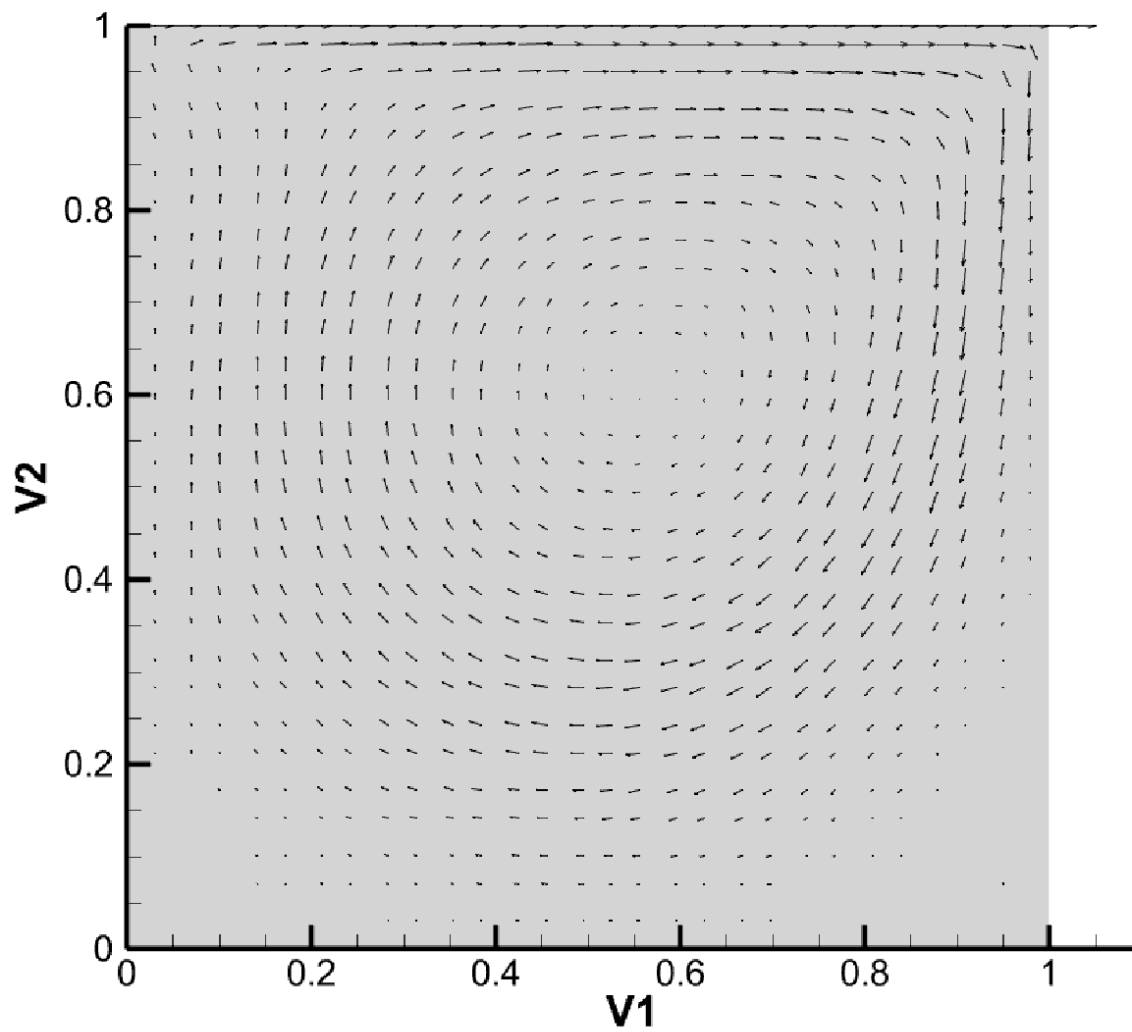
Re = 400 ; Grid Size = 100 × 100 ; Vorticity(omega)



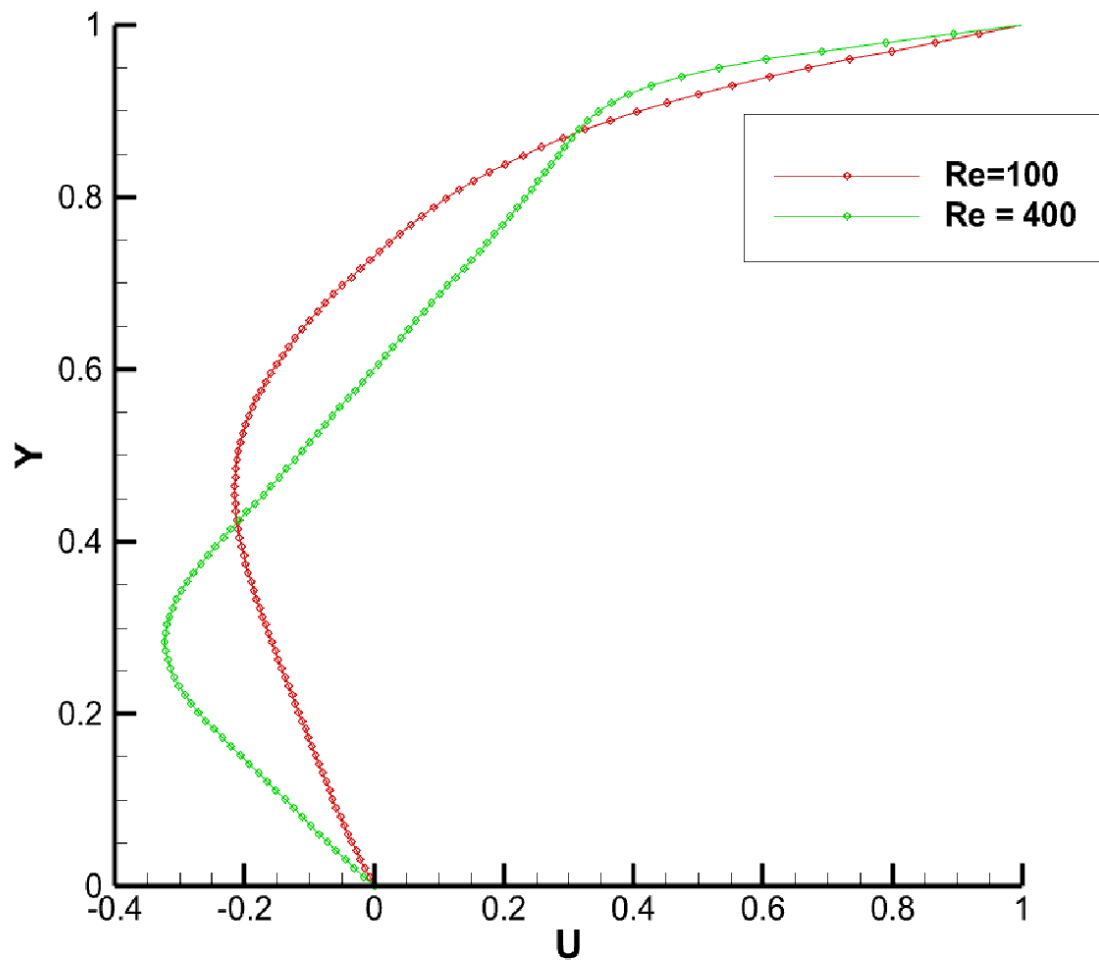
Re = 100 ; Grid Size = 100 × 100 ; Velocity Vector graph



Re = 400 ; Grid Size = 100 × 100 ; Velocity Vector graph



### Centerline velocity (U)



### Center line velocity (V)

