ASSIGNMENT-3
COMPUTATIONAL FLUID DYNAMICS

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Governing equations in Discretized form:

- Discretized equation of stream function(ψ)

$$\psi_{i,j} = \frac{\psi_{i+1,j} + \psi_{i-1,j} + \beta^2(\psi_{i,j+1} + \psi_{i,j-1}) + \Delta x^2 \omega_{i,j}}{2(1 + \beta^2)}$$

- Discretized equation of vorticity(ω)

$\boldsymbol{\omega_{i,j}}$

$$= \frac{\omega_{i+1,j} + \omega_{i-1,j} + \beta^2(\omega_{i,j+1} + \omega_{i,j-1}) - \frac{1}{4}\beta Re(\omega_{i+1,j} - \omega_{i-1,j})(\psi_{i,j+1} + \psi_{i,j-1}) + \frac{1}{4}\beta Re(\omega_{i,j+1} - \omega_{i,j-1})(\psi_{i+1,j} - \psi_{i-1,j})}{2(1 + \beta^2)}$$

Boundary Conditions

- Boundary conditions for stream function(ψ)

Vertical walls: For $1 \leq j \leq j_{max}$, $\psi_{1,j} = \psi_{i_{max},j} = 0$
Horizontal walls: For $1 \leq i \leq i_{max}$, $\psi_{i,1} = \psi_{i,j_{max}} = 0$

- Boundary conditions for vorticity(ω)

At the left side-wall,

$$\omega_{1,j} = -\frac{2\psi_{2,j}}{(\Delta x)^2} \quad \text{for } 2 \leq j \leq j_{max-1}$$

At the right side wall,

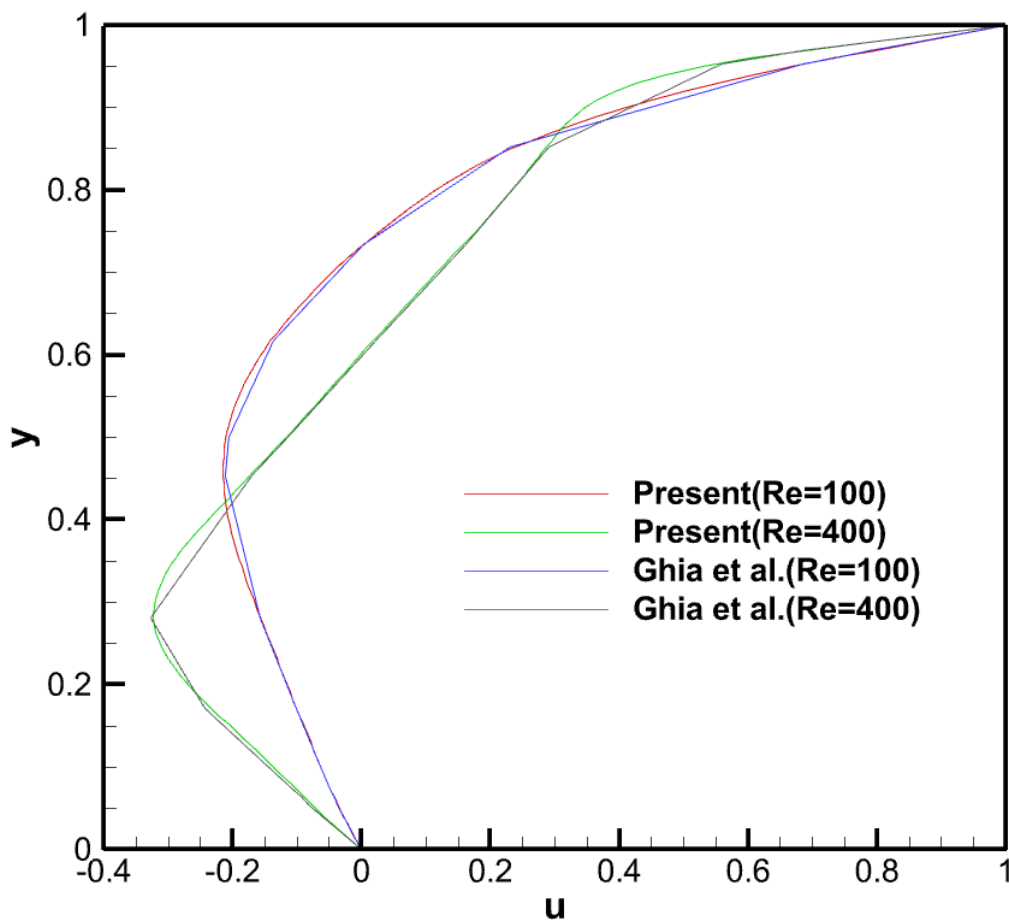$$\omega_{i_{max},j} = -\frac{2\psi_{i_{max-1},j}}{(\Delta x)^2} \quad \text{for } 2 \leq j \leq j_{max-1}$$

At the bottom wall,

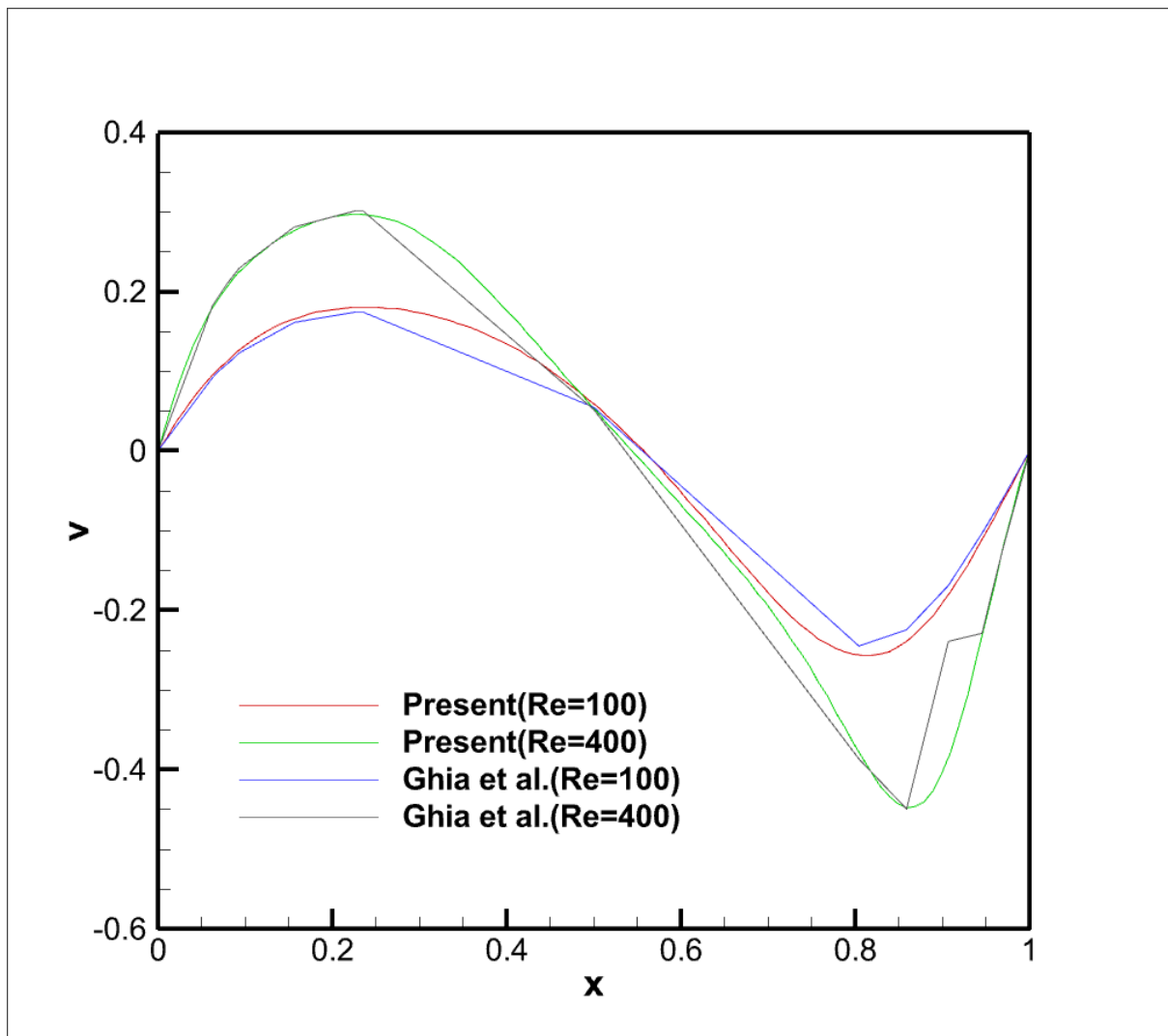$$\omega_{i,1} = -\frac{2\psi_{i,2}}{(\Delta y)^2} \quad \text{for } 2 \le i \le i_{max-1}$$

At the top wall,

$$\omega_{i,j_{max}} = -\frac{2\psi_{i,j_{max-1}} + 2\Delta yU}{(\Delta y)^2} \quad \text{for } 2 \le i \le i_{max-1}$$
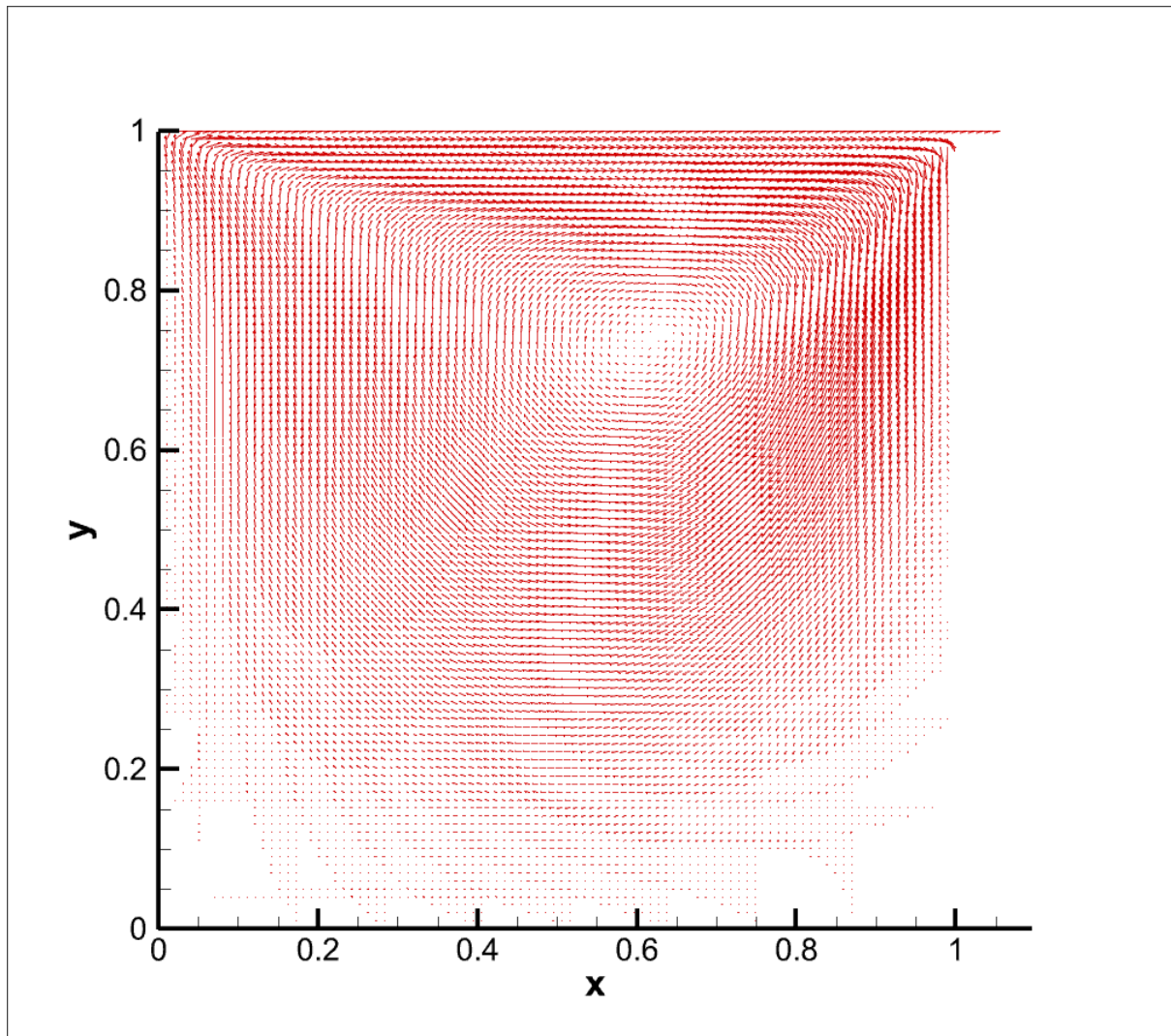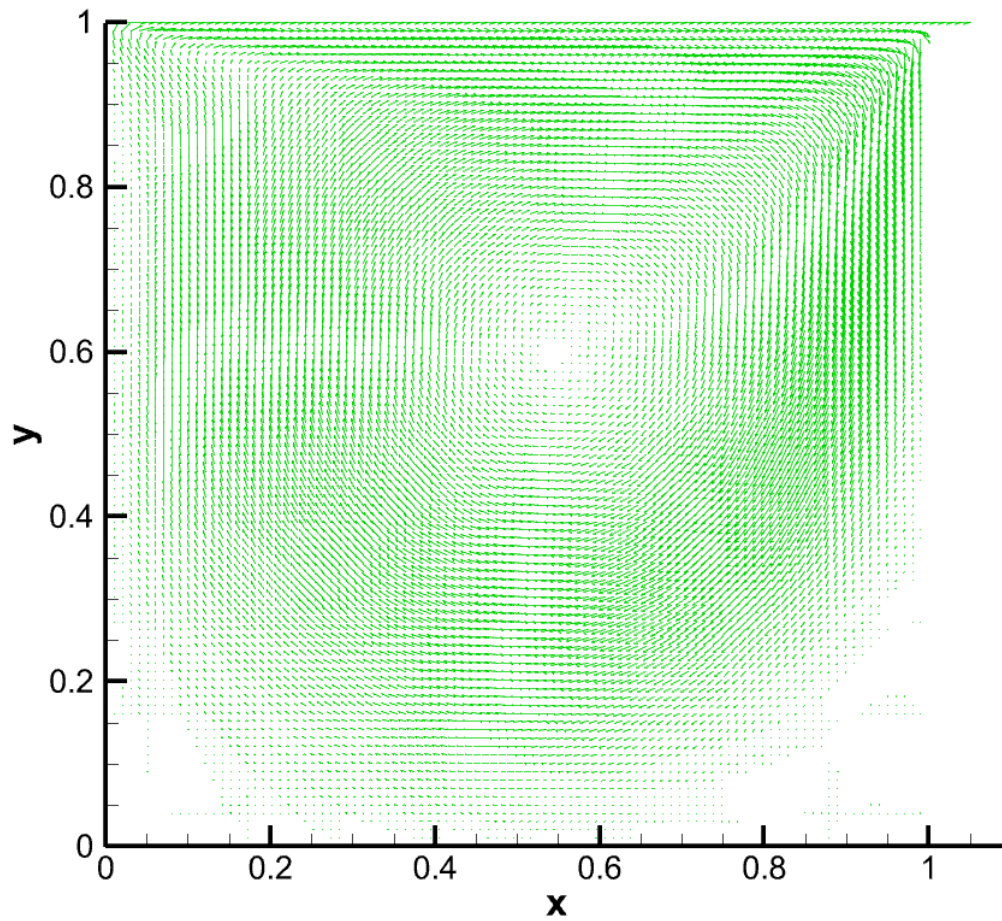
1. Centre Line horizontal velocity:

2.Centre Line vertical velocity:

3.velocity vector(re=100):

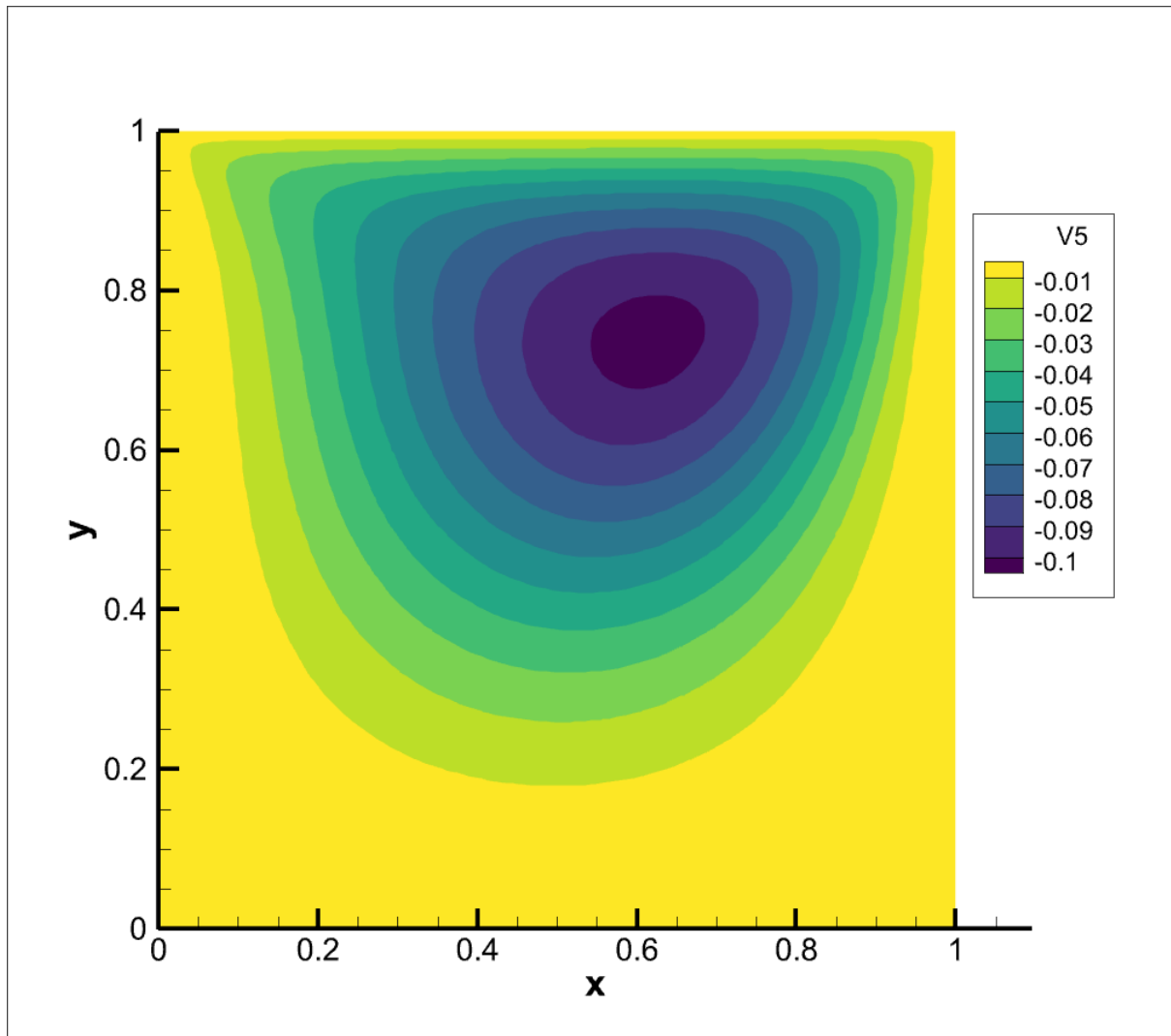## 4.velocity vector(re=400):

5.streamline plot(re=100):

6.streamline plot(re=400):