

ME634A Assignment-4 :
3D lid driven cavity (laminar) using RK3-CN method

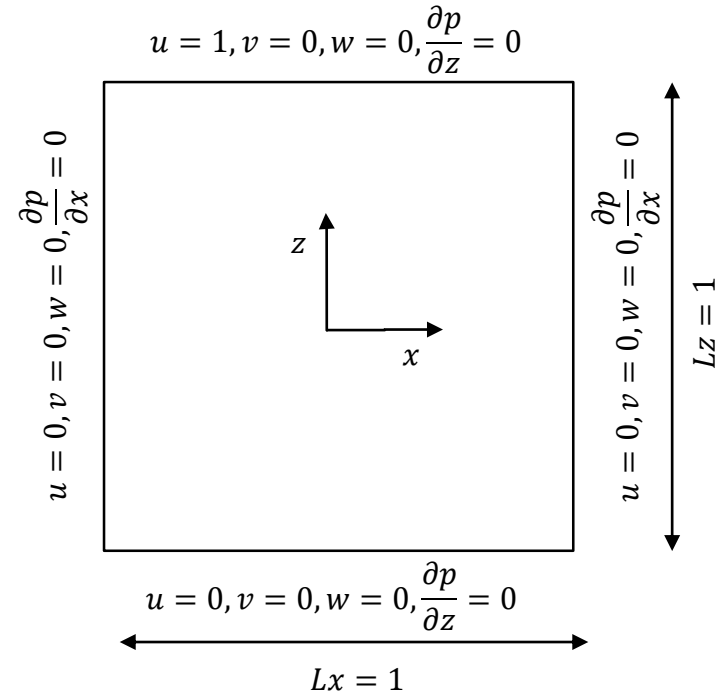
Shreya Agrawal (160662)

Problem Description

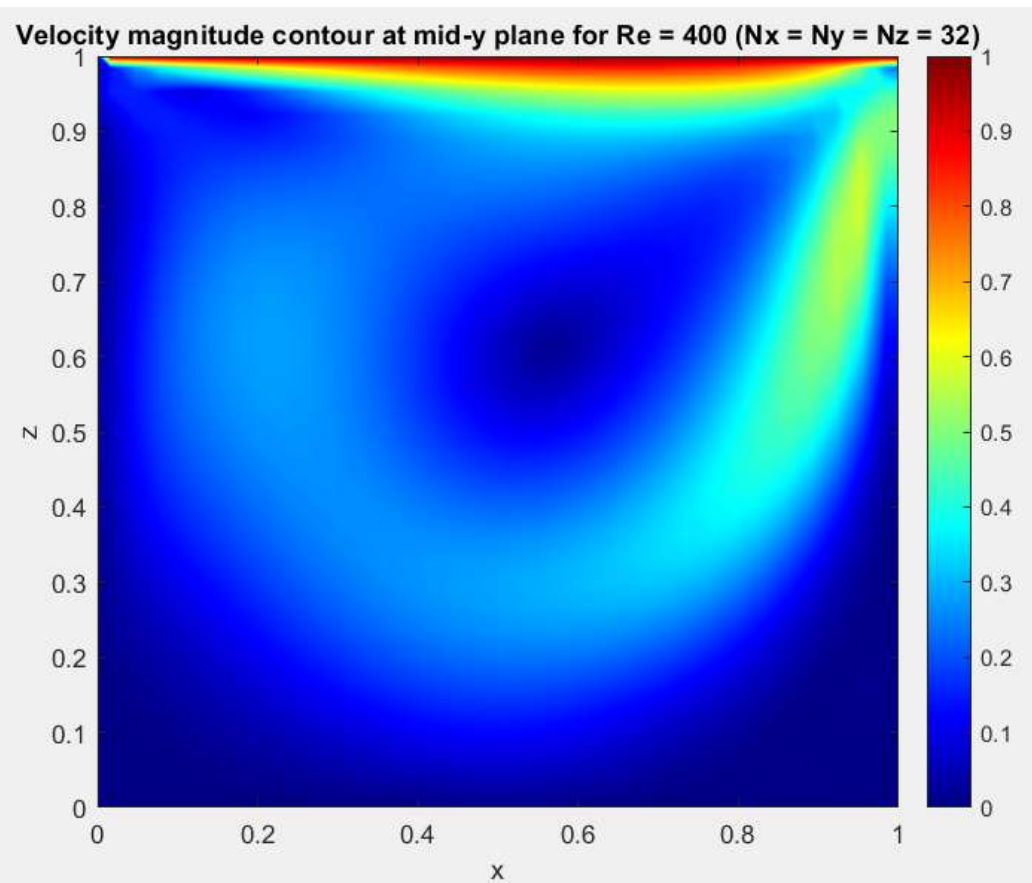
- Periodic boundary condition in y direction.
- 3D laminar problem.
- Solved for a uniform grid (though the code is well-equipped to solve for a non-uniform grid as well).
- Non-dimensional form of x-momentum equation:

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} = -\frac{\partial p}{\partial x} + \frac{1}{Re} \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right)$$

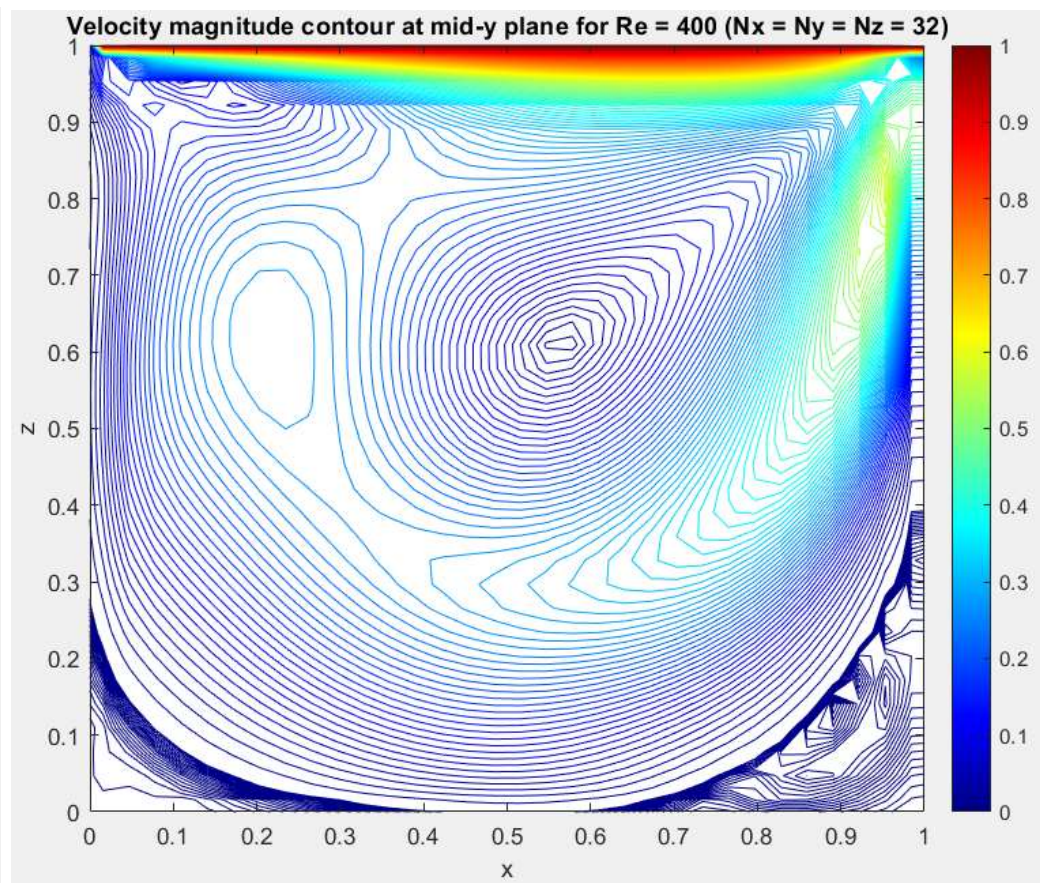
- Similarly, y and z momentum equations.
- Tolerance for time-marching = 1.0e-4 (i.e. steady state stopping criterion: residual < tolerance).



Results



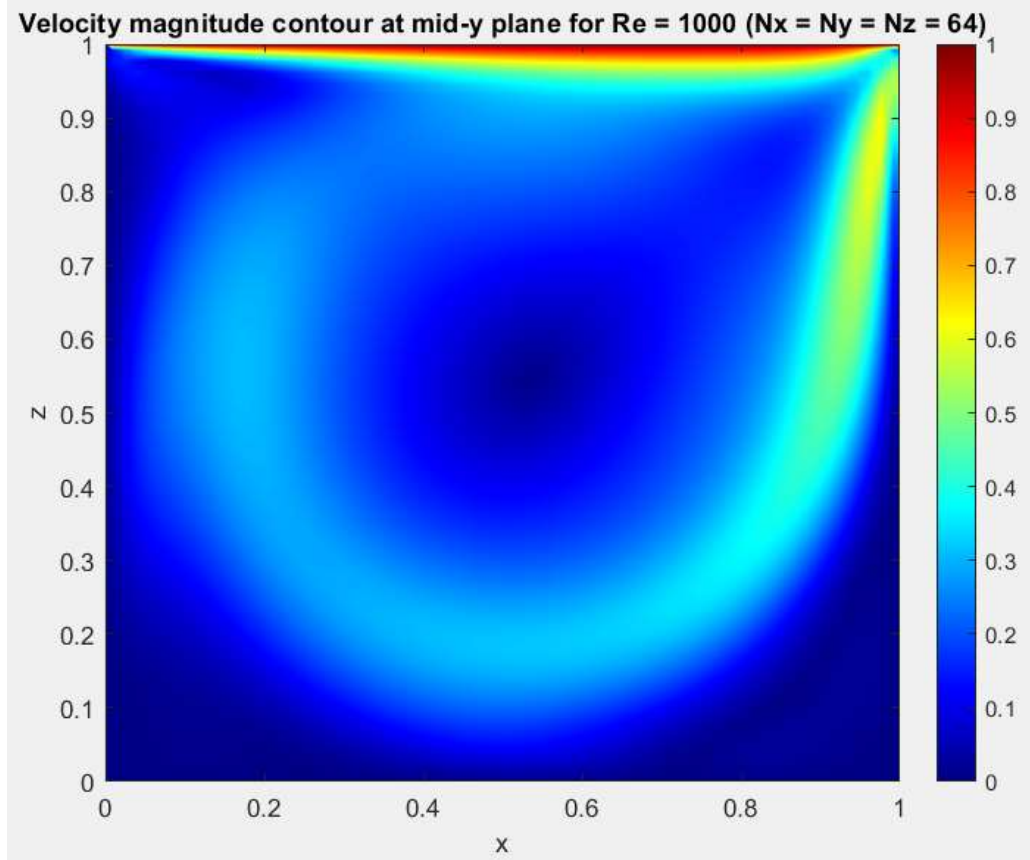
(a)



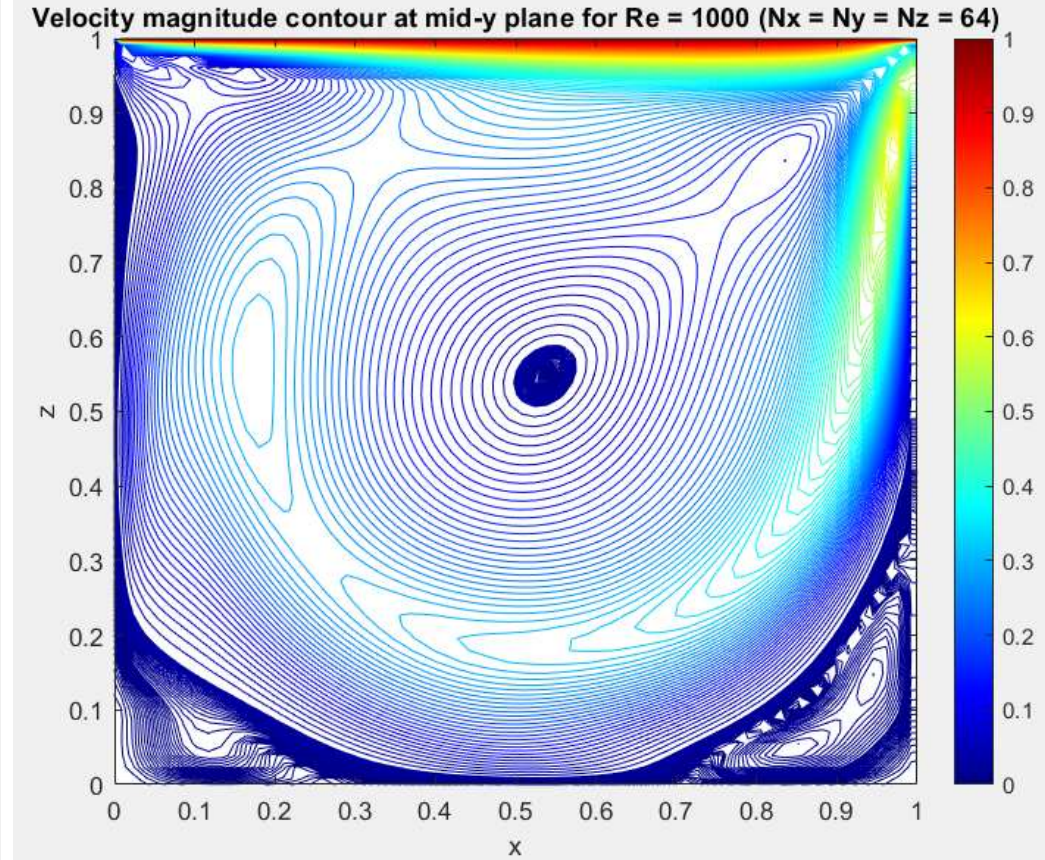
(b)

Velocity magnitude contours for $Re = 400$ ($N_x = N_y = N_z = 32$), $t = 50$ s: (a) filled contour, (b) line contour

Results



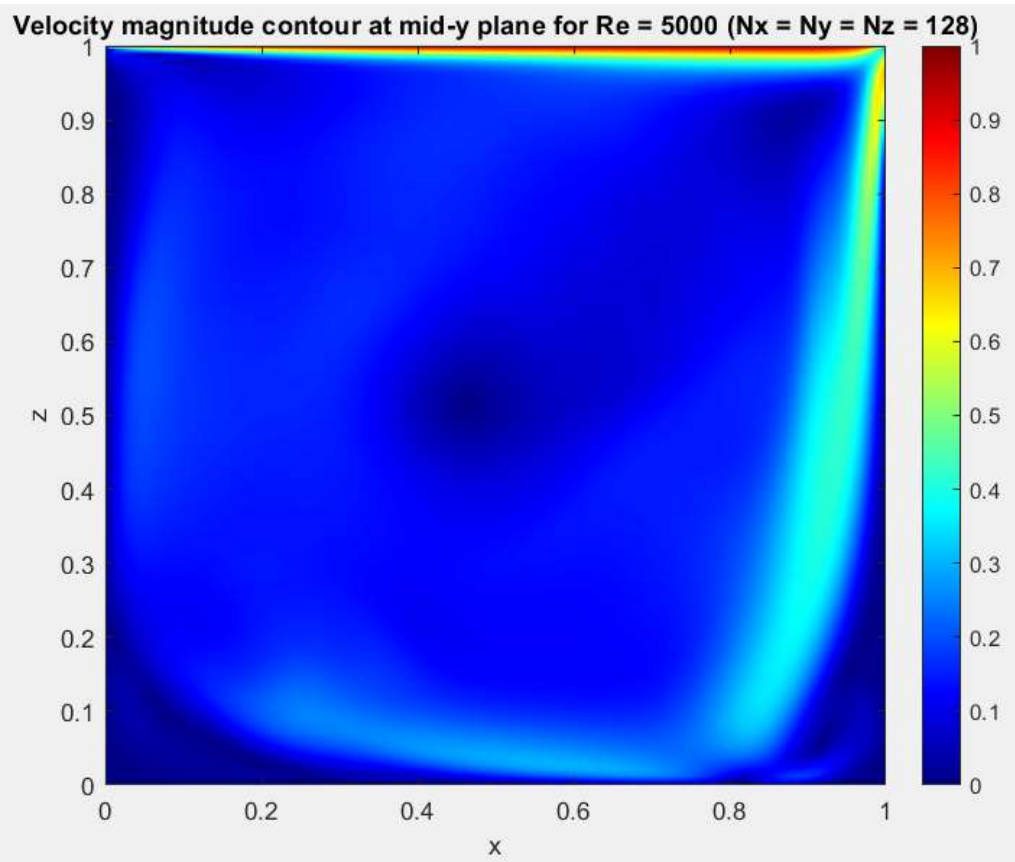
(a)



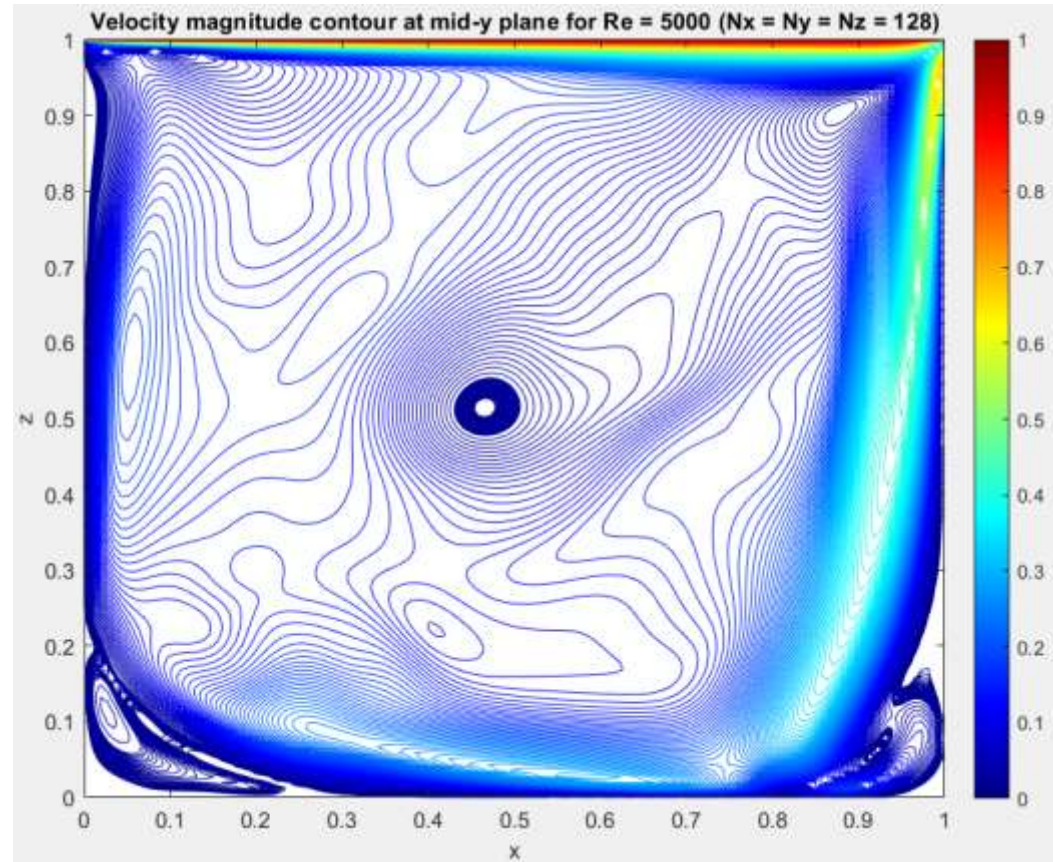
(b)

Velocity magnitude contours for $Re = 1000$ ($N_x = N_y = N_z = 64$), $t = 100$ s: (a) filled contour, (b) line contour

Results



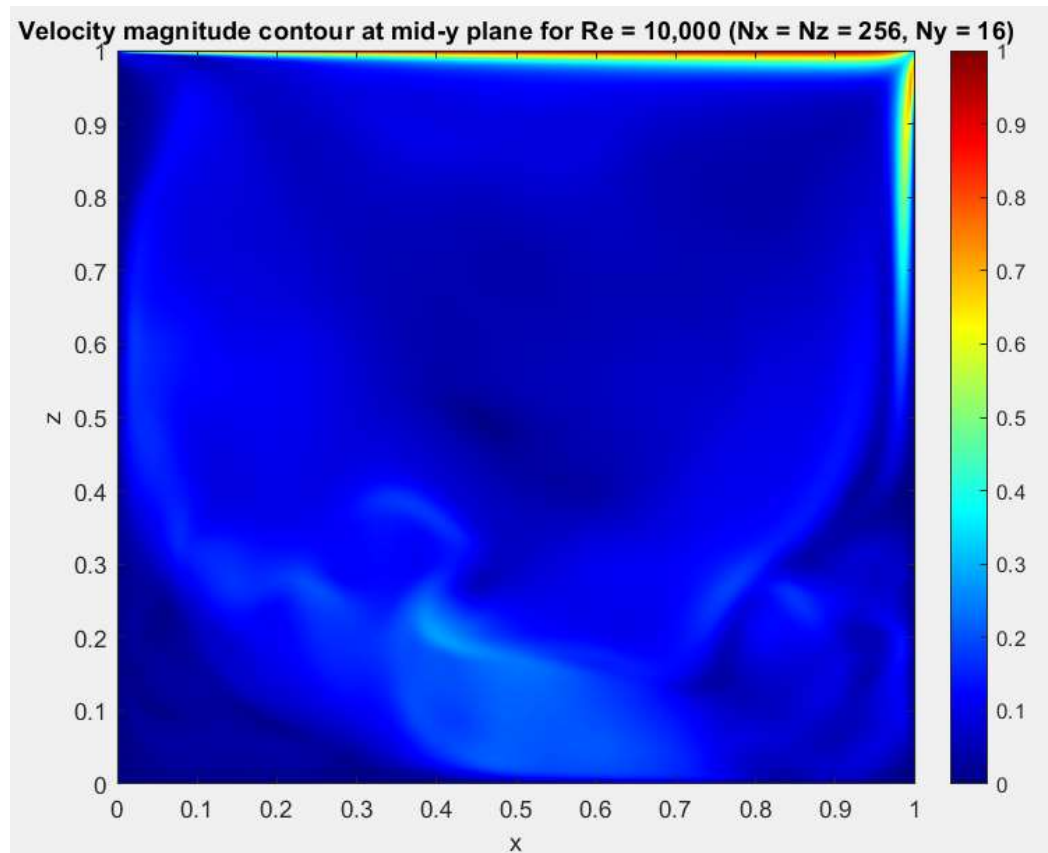
(a)



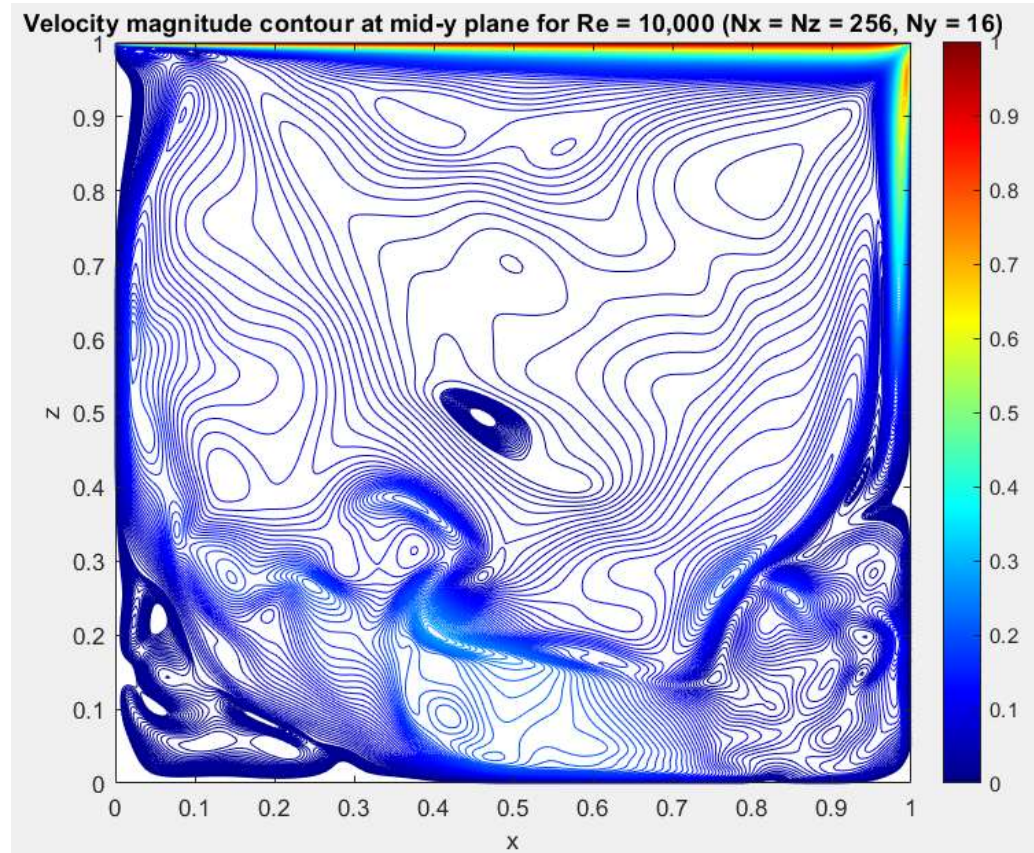
(b)

Velocity magnitude contours for $Re = 5000$ ($N_x = N_y = N_z = 128$), $t = 100$ s : (a) filled contour, (b) line contour

Results



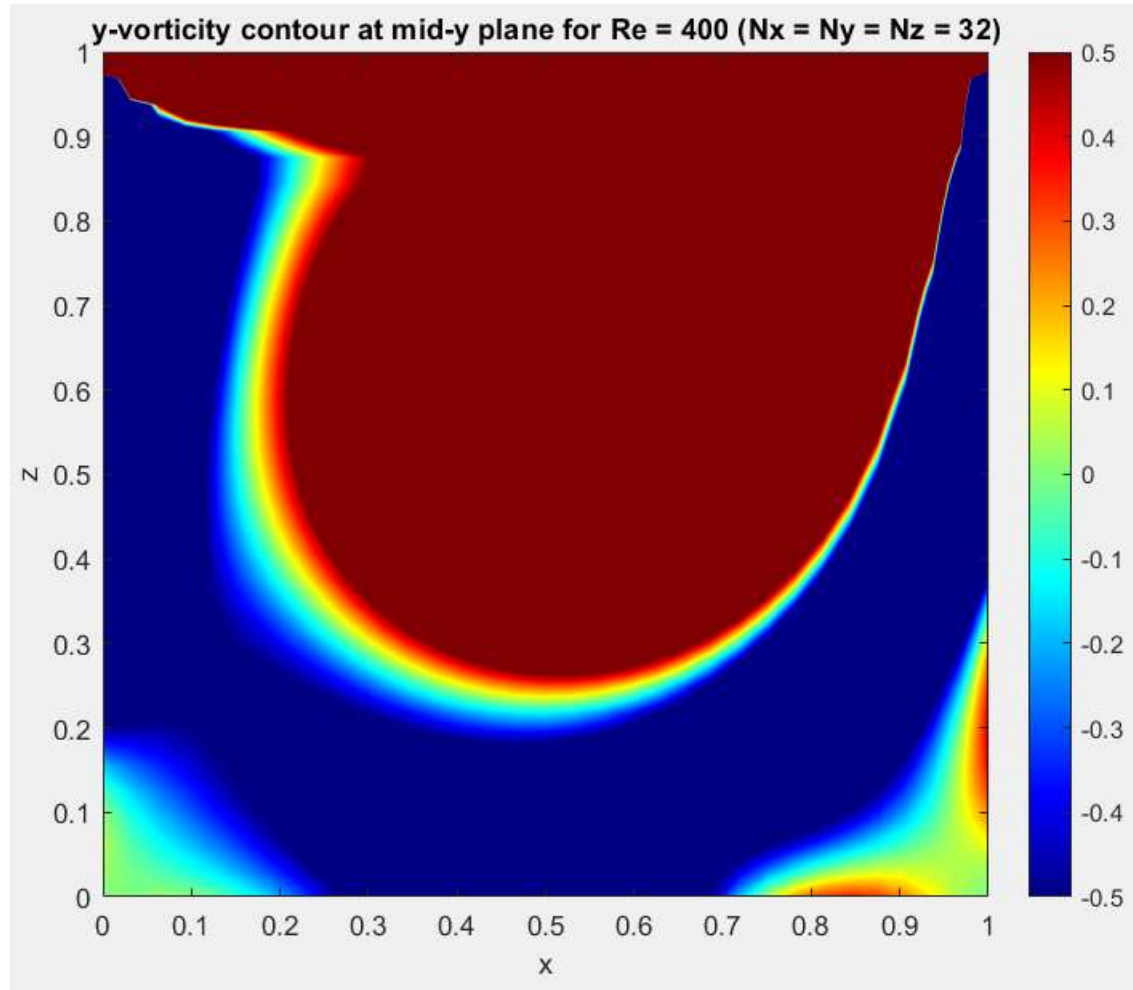
(a)



(b)

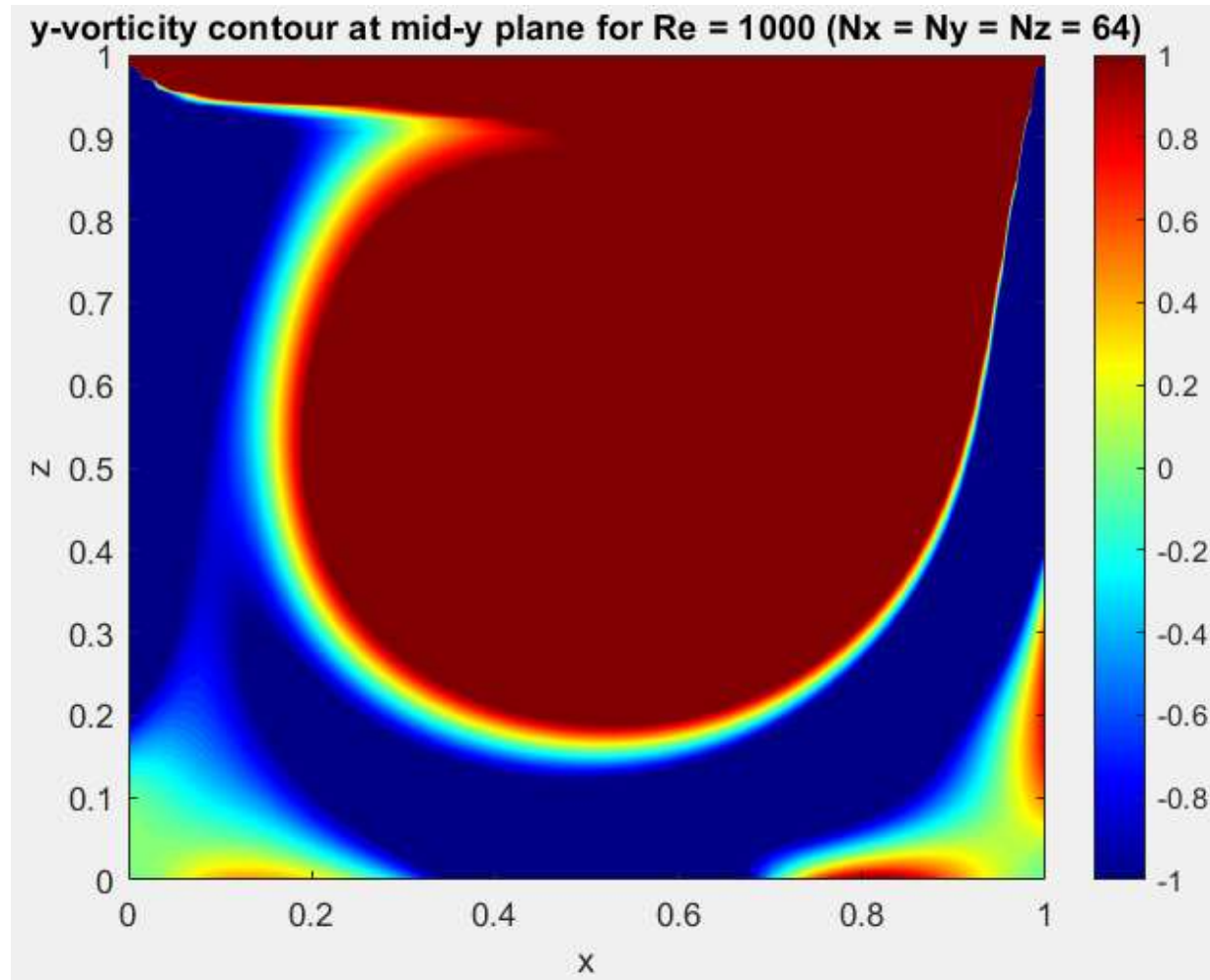
Velocity magnitude contours for $Re = 10,000$ ($N_x = N_z = 256$, $N_y = 16$), $t = 150$ s : (a) filled contour, (b) line contour

Results



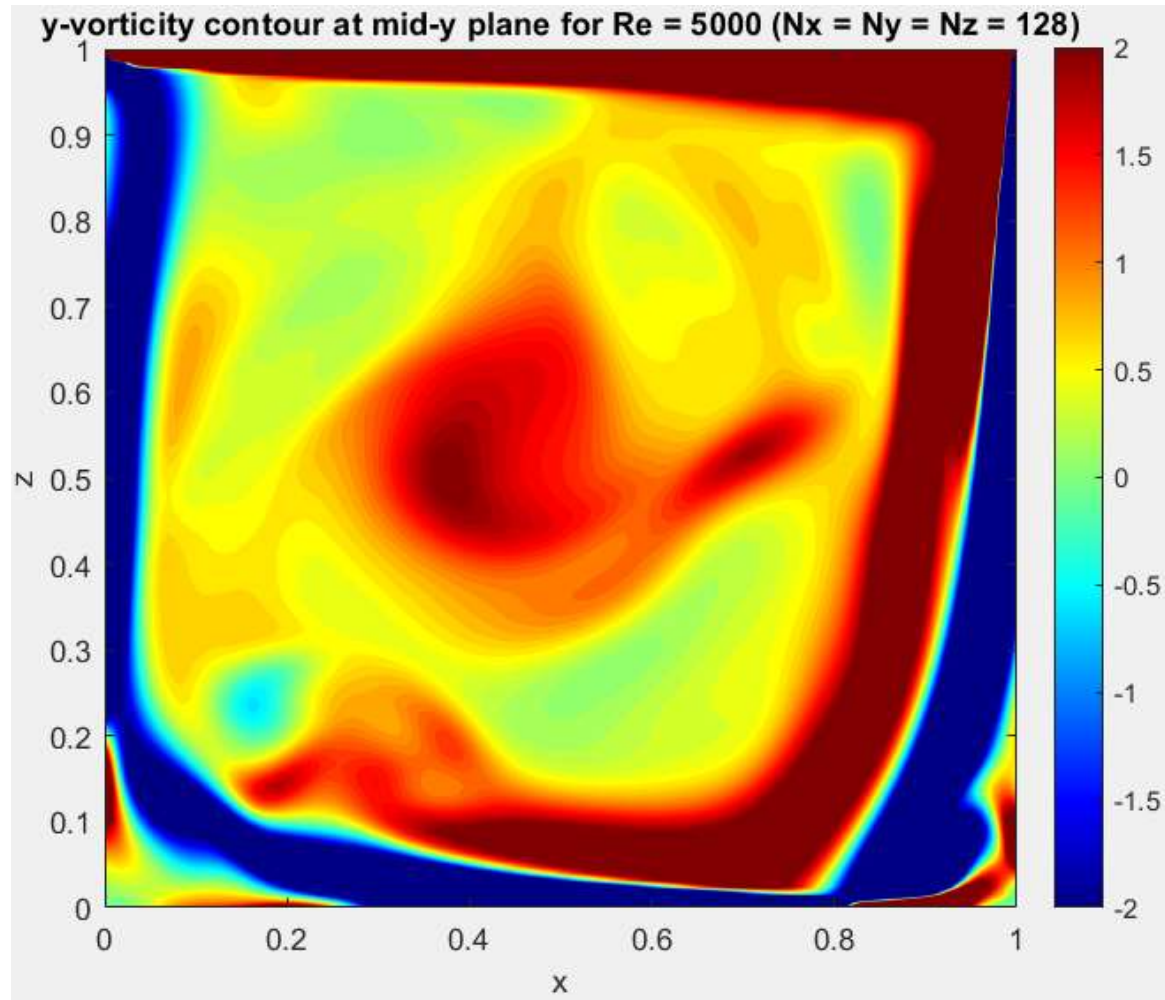
y-vorticity contour for $Re = 400$ ($N_x = N_y = N_z = 32$), $t = 50$ s

Results



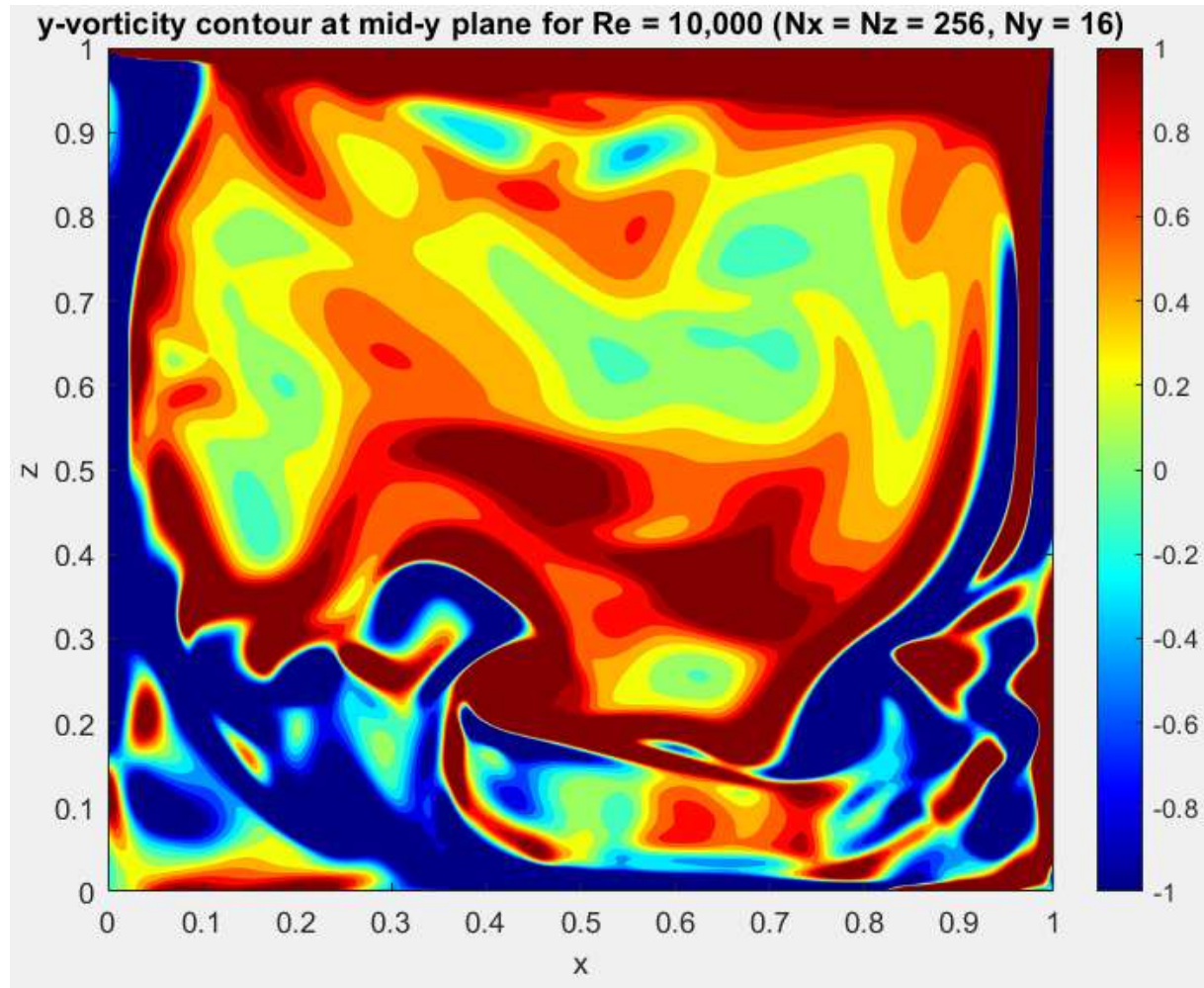
y-vorticity contour for $Re = 1000$ ($N_x = N_y = N_z = 64$), $t = 100$ s

Results



y-vorticity contours for $Re = 5000$ ($N_x = N_y = N_z = 128$), $t = 100$ s

Results



y-vorticity contours for $Re = 10,000$ ($N_x = N_z = 256$, $N_y = 16$), $t = 150$ s