ME634A End-Sem assignment - Part I:
Two-dimensional stretching of a circle in a shear velocity field using CLSVOF method

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Problem Description

- Periodic boundary condition in z direction.
- 3D laminar problem.
- Solved for a uniform grid (though the code is well-equipped to solve for a non-uniform grid as well).
- Equations to be solved:

$$\phi_t + \boldsymbol{u} \cdot \nabla \phi = 0$$
$$F_t + \boldsymbol{u} \cdot \nabla F = 0$$

- Shearing velocity field (Dirichlet B.C. in x-y):

$$u = -(\sin \pi x)^2 \sin(2\pi y) \cos(\pi t/T)$$
$$v = (\sin \pi y)^2 \sin(2\pi x) \cos(\pi t/T)$$
$$w = 0$$

  where T = 8.
- Neumann B.C. for Level Set function (ϕ) and Volume of Fluid function (F) in x-y directions.
- Interface thickness: $\epsilon = 1.75 * (grid\ size)$
- Domain: [0,1] × [0,1] × [0,0.5]
- Circle radius = 0.15; circle-center = (0.5,0.75,0.25)

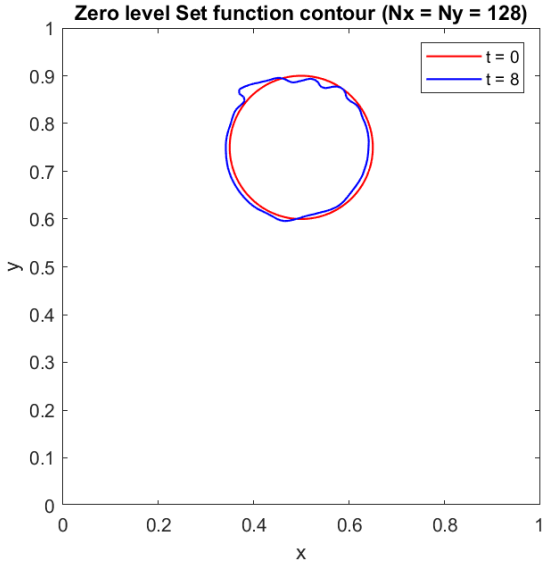
2D code results

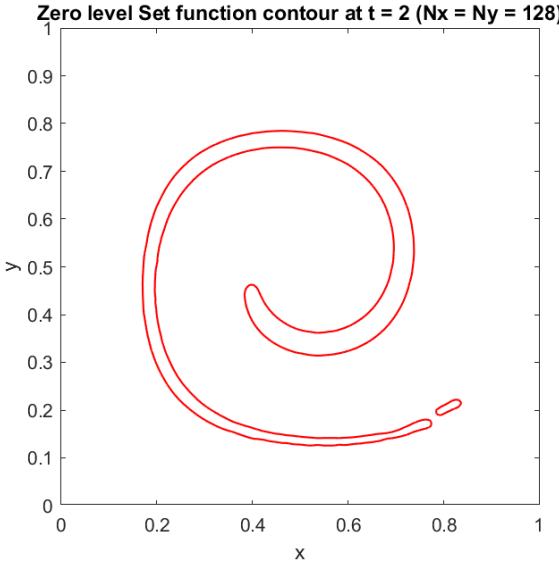
No. of Cells:

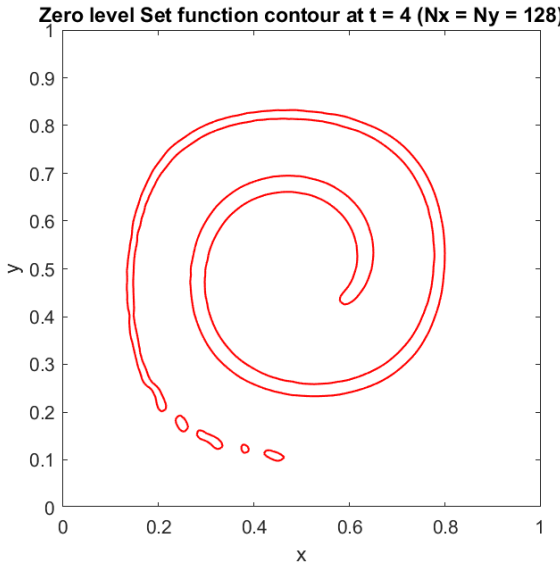
$N_x = 128$

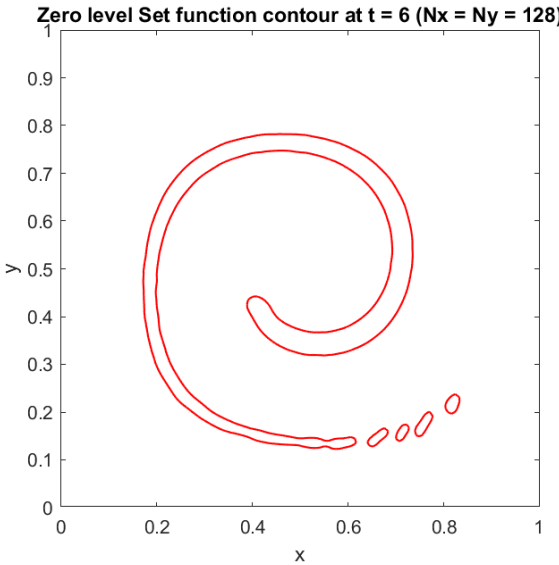
$N_y = 128$

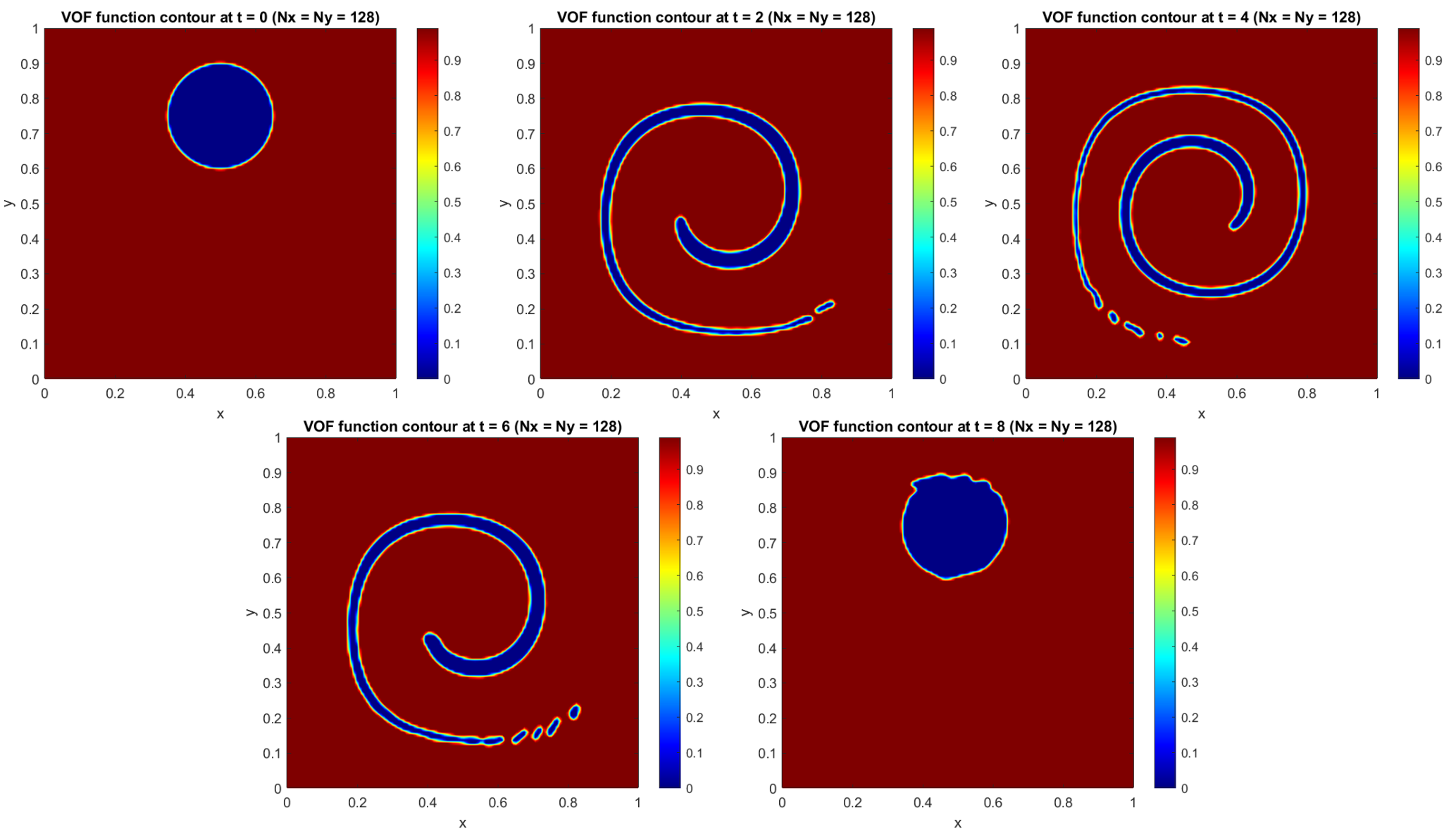
CFL no. = 0.25









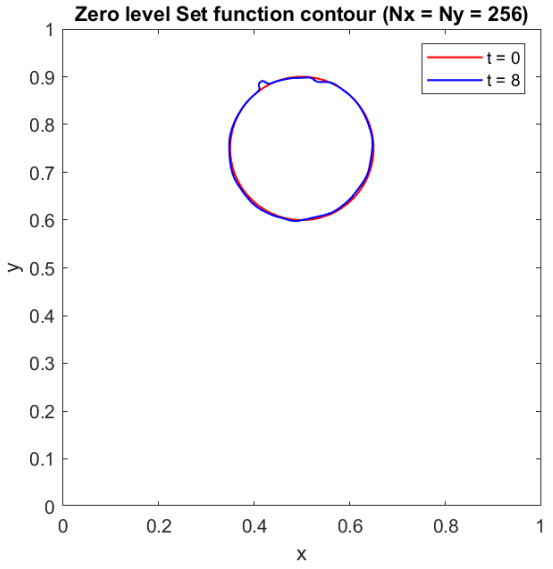

VOF function contour at t = 0 (Nx = Ny = 128)
VOF function contour at t = 2 (Nx = Ny = 128)
VOF function contour at t = 4 (Nx = Ny = 128)
VOF function contour at t = 6 (Nx = Ny = 128)
VOF function contour at t = 8 (Nx = Ny = 128)
x
y
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

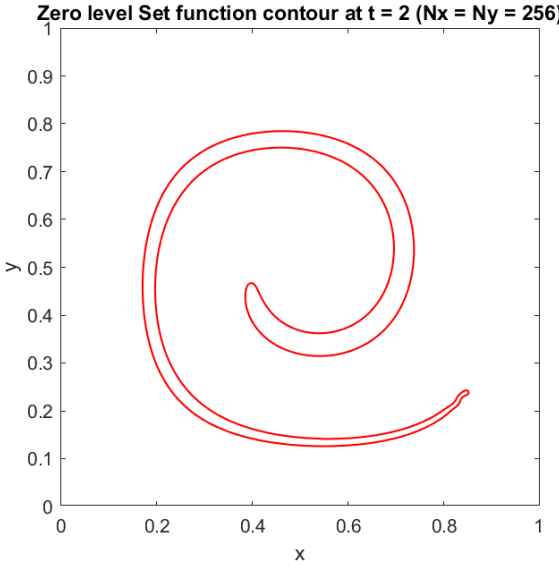
No. of Cells:

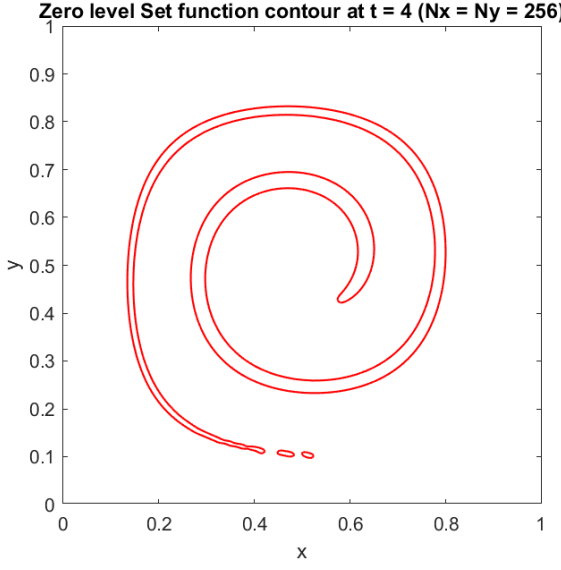
$N_x = 256$

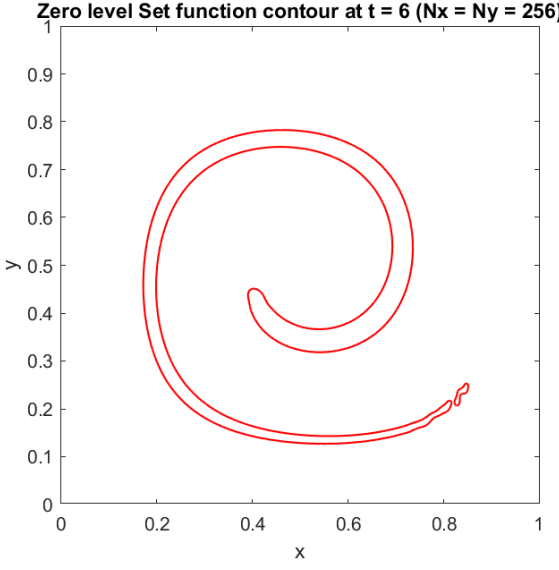
$N_y = 256$

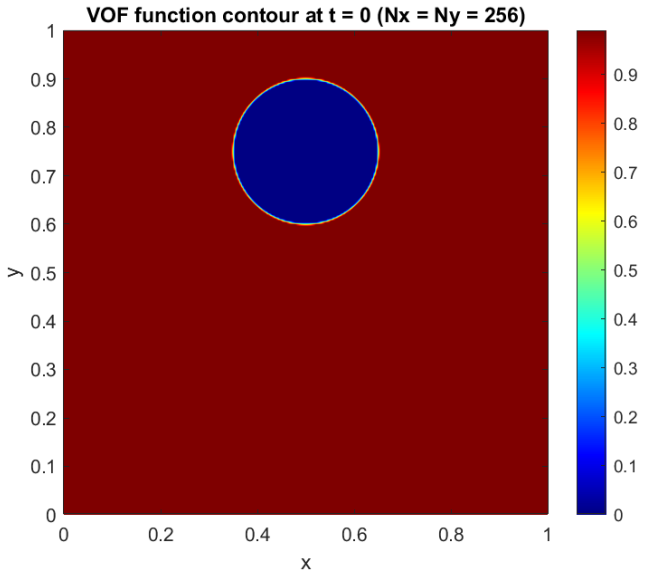
CFL no. = 0.25

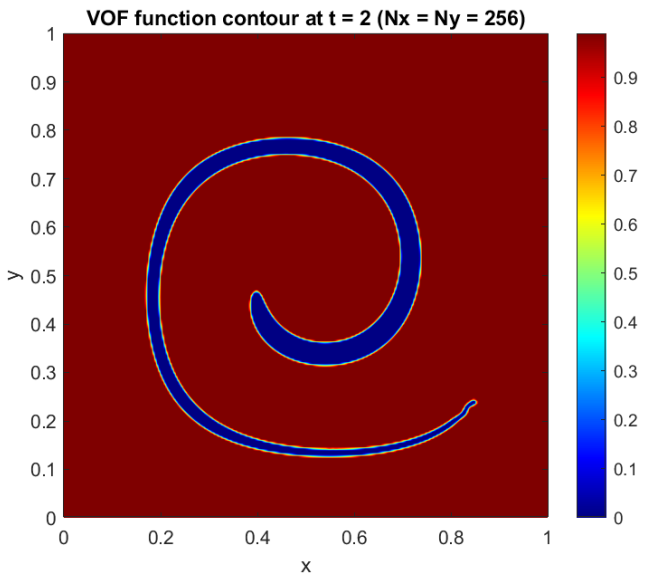


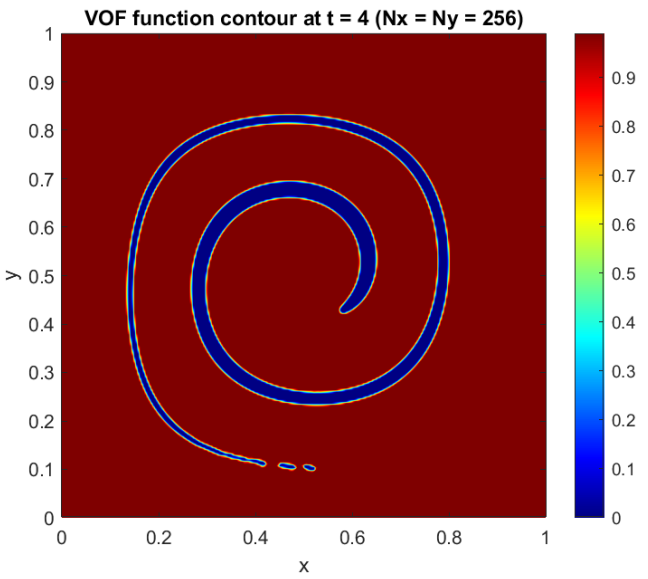


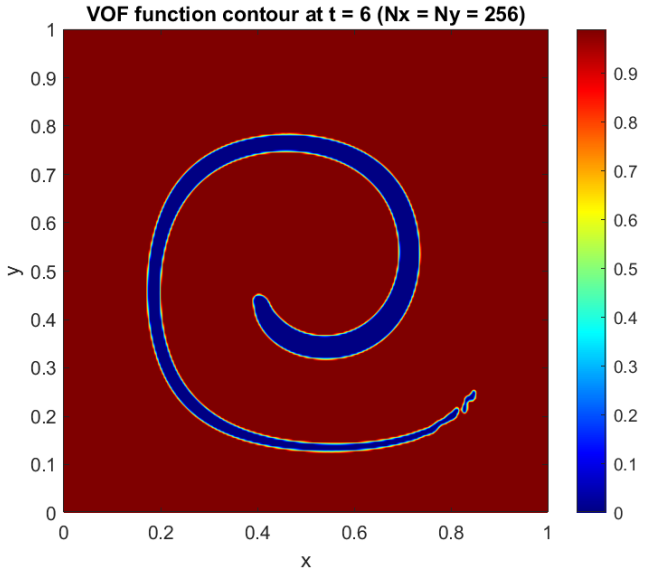


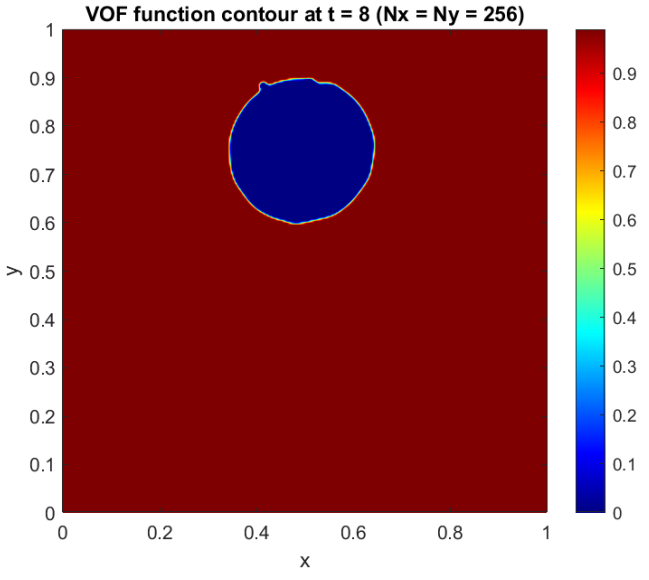



VOF function contour at t = 0 (Nx = Ny = 256)
x
y


VOF function contour at t = 2 (Nx = Ny = 256)
x
y


VOF function contour at t = 4 (Nx = Ny = 256)
x
y


VOF function contour at t = 6 (Nx = Ny = 256)
x
y


VOF function contour at t = 8 (Nx = Ny = 256)
x
y

3D code results (at mid-z plane)

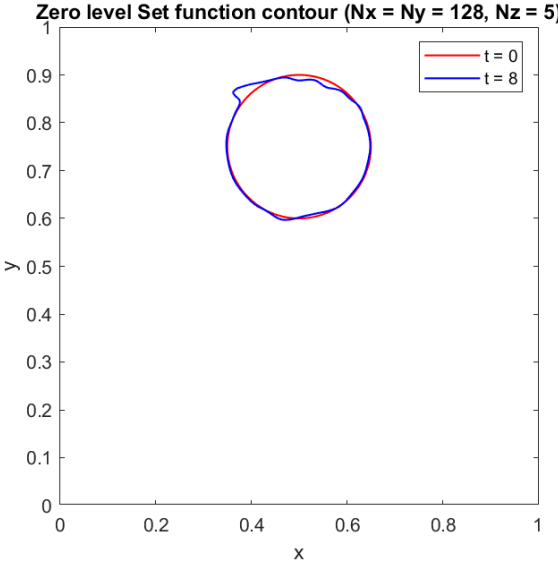
No. of Cells:

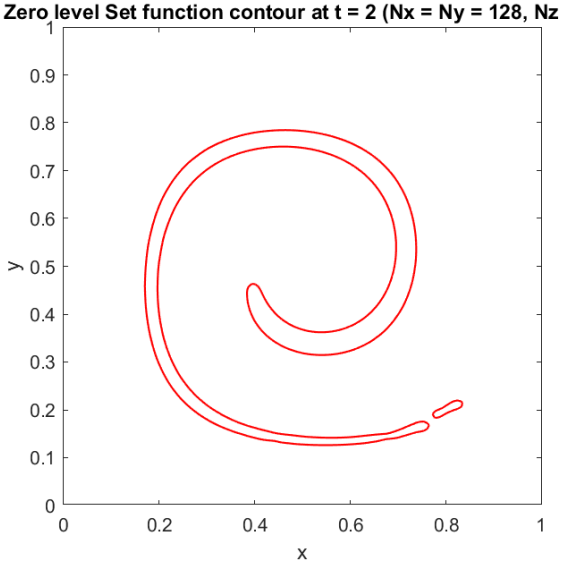
$N_x = 128$

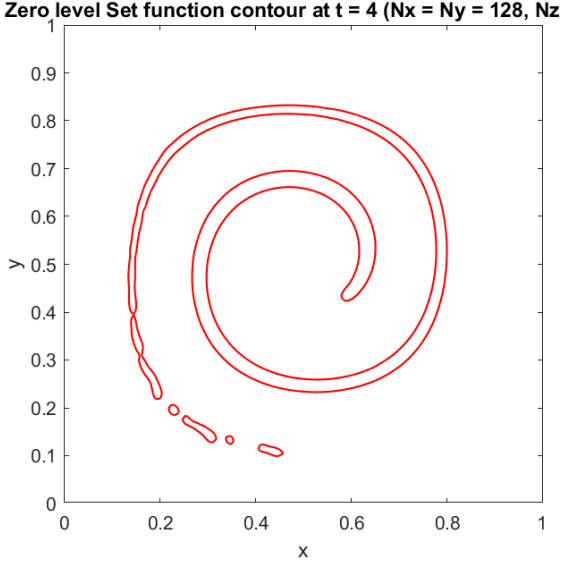
$N_y = 128$

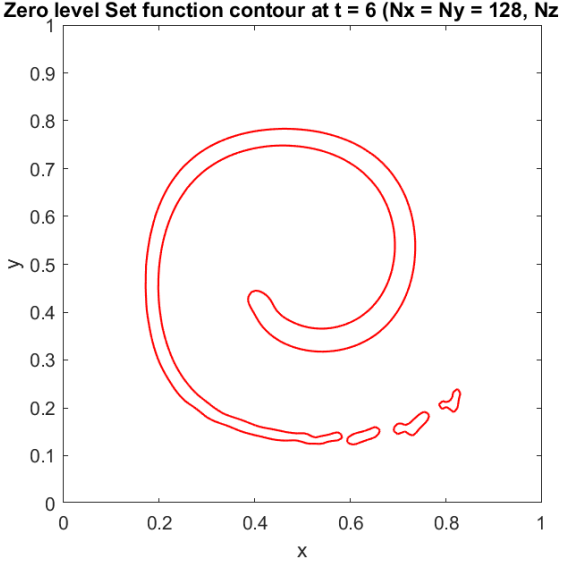
$N_z = 5$

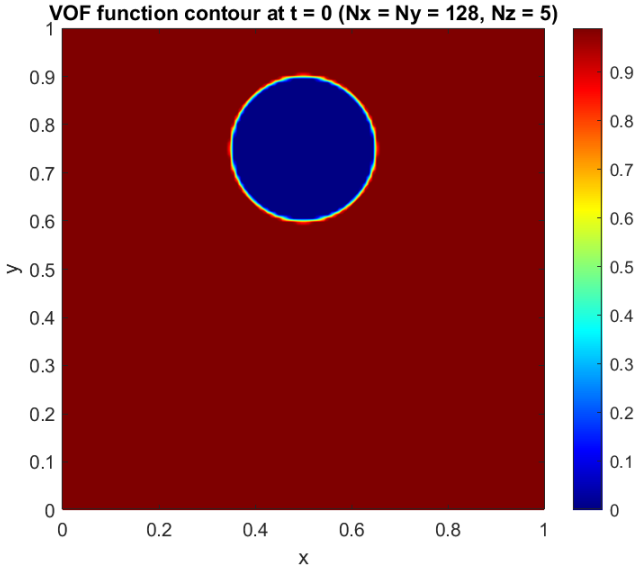
CFL no. = 0.05

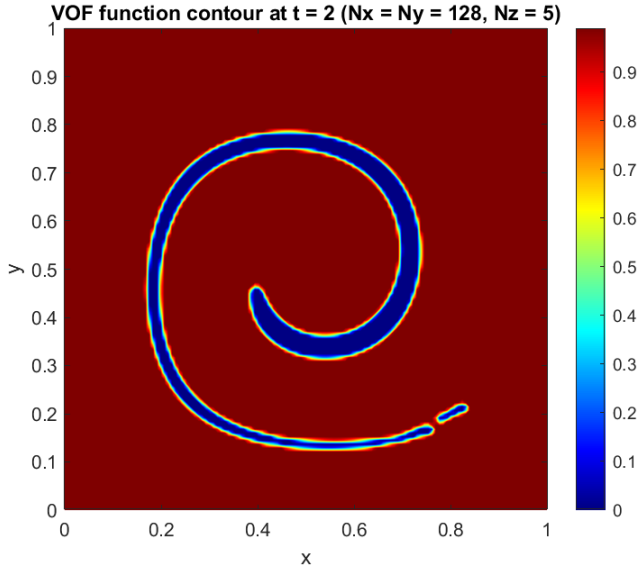


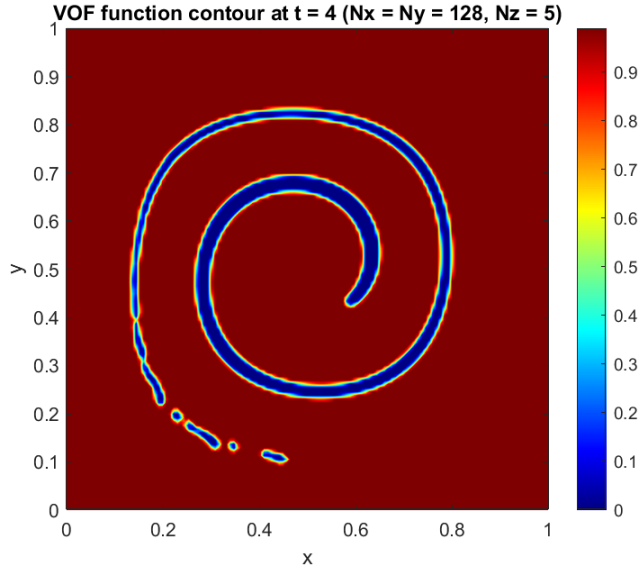


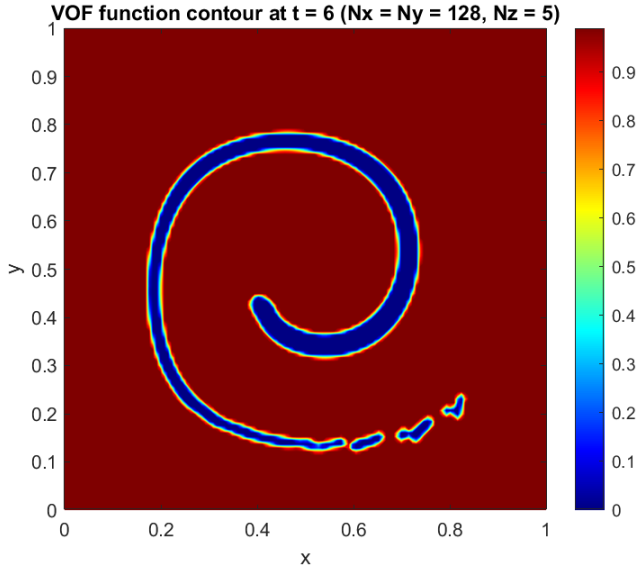


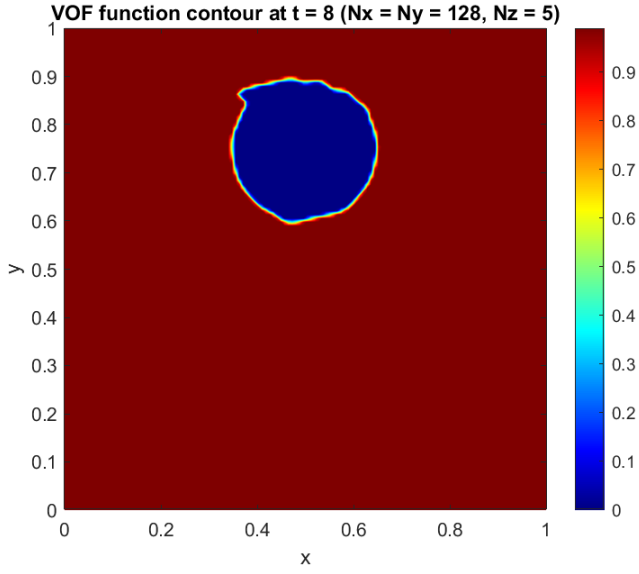



VOF function contour at t = 0 (Nx = Ny = 128, Nz = 5)
x
y


VOF function contour at t = 2 (Nx = Ny = 128, Nz = 5)
x
y


VOF function contour at t = 4 (Nx = Ny = 128, Nz = 5)
x
y


VOF function contour at t = 6 (Nx = Ny = 128, Nz = 5)
x
y


VOF function contour at t = 8 (Nx = Ny = 128, Nz = 5)
x
y

ME634A End-Sem assignment – Part II : Three-dimensional deformation of a sphere in a shear velocity field using CLSVOF method

Problem Description

- 3D laminar problem.
- Solved for a uniform grid (though the code is well-equipped to solve for a non-uniform grid as well).
- Equations to be solved:

$$\phi_t + \boldsymbol{u} \cdot \nabla \phi = 0$$
$$F_t + \boldsymbol{u} \cdot \nabla F = 0$$

- Shearing velocity field (Dirichlet B.C. in x-y-z):

$$u = 2(\sin \pi x)^2 \sin(2\pi y) \sin(2\pi z) \cos(\pi t/T)$$
$$v = -(\sin \pi y)^2 \sin(2\pi x) \sin(2\pi z) \cos(\pi t/T)$$
$$w = -(\sin \pi z)^2 \sin(2\pi x) \sin(2\pi y) \cos(\pi t/T)$$

  where T = 3.
- Neumann B.C. for Level Set function (ϕ) and Volume of Fluid function (F) in x-y-z directions.
- Interface thickness: $\epsilon = 1.75 * (grid\ size)$
- Domain: [0,1] × [0,1] × [0,1]
- Circle radius = 0.15; circle-center = (0.35,0.35,0.35)

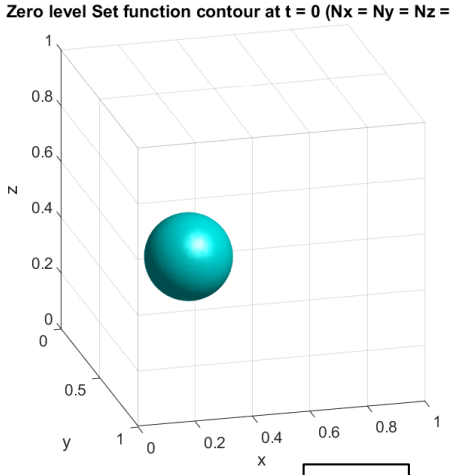
No. of Cells:

$N_x = 64$

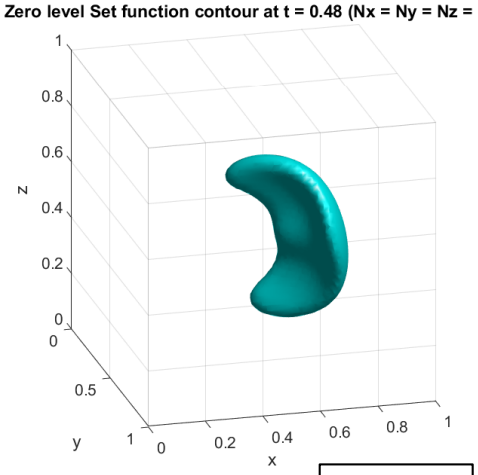
$N_y = 64$

$N_z = 64$

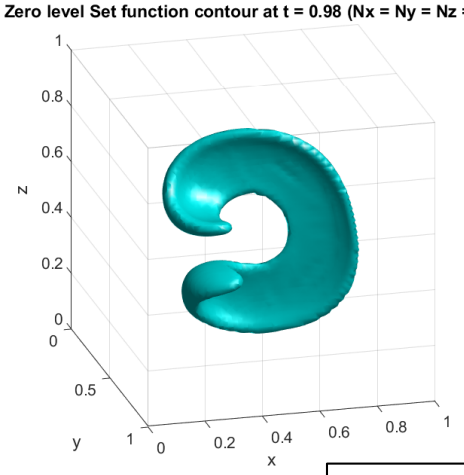
CFL no. = 0.25



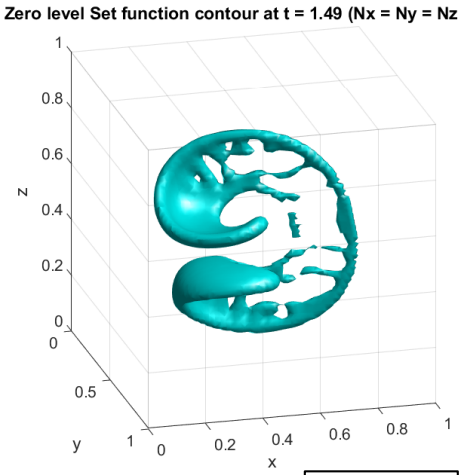
t = 0



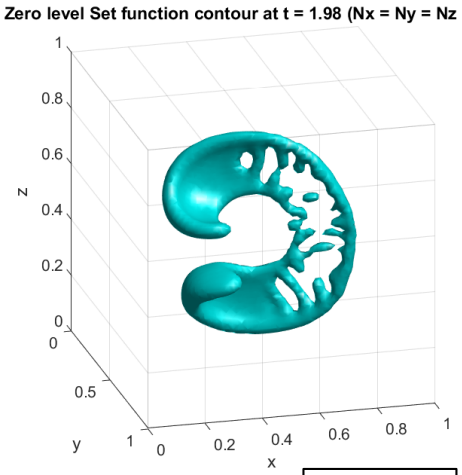
t = 0.48



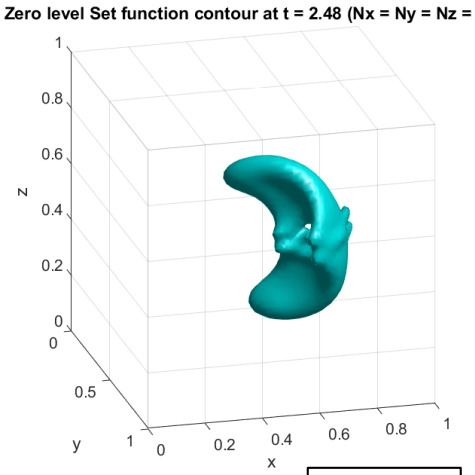
t = 0.98



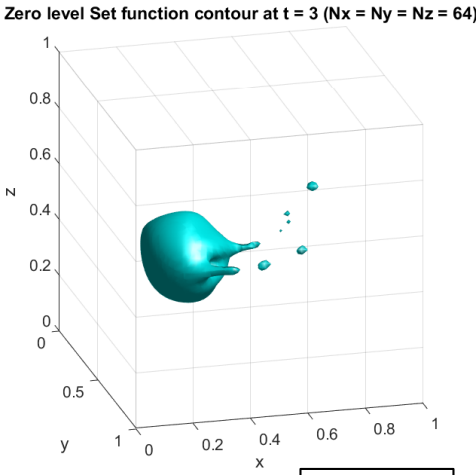
t = 1.49



t = 1.98



t = 2.48



t = 3 = T

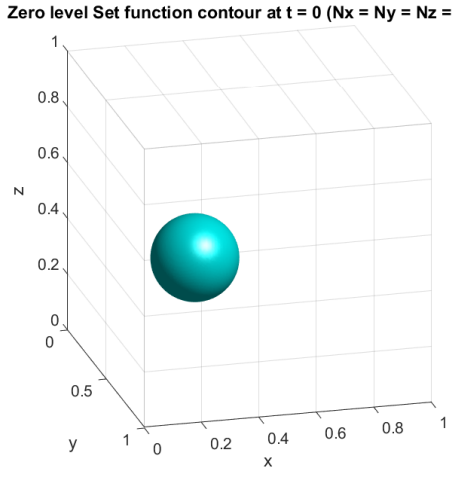
No. of Cells:

$N_x = 128$

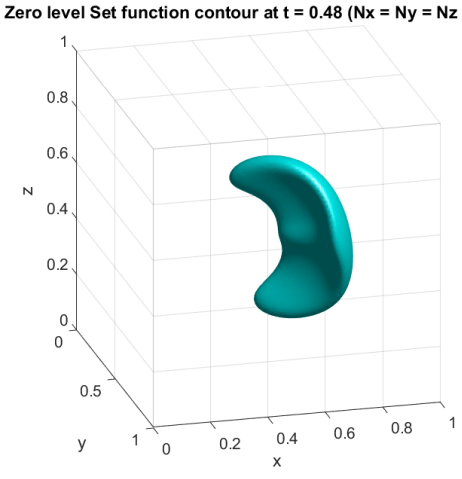
$N_y = 128$

$N_z = 128$

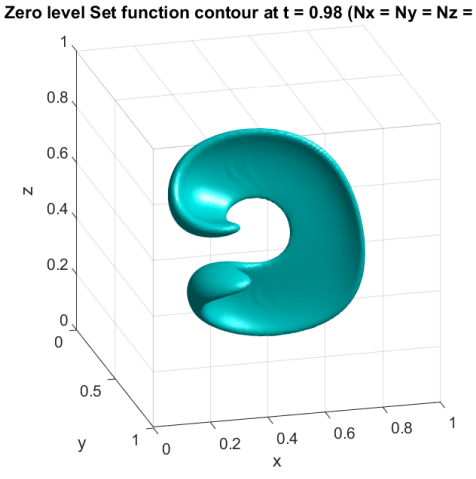
CFL no. = 0.25



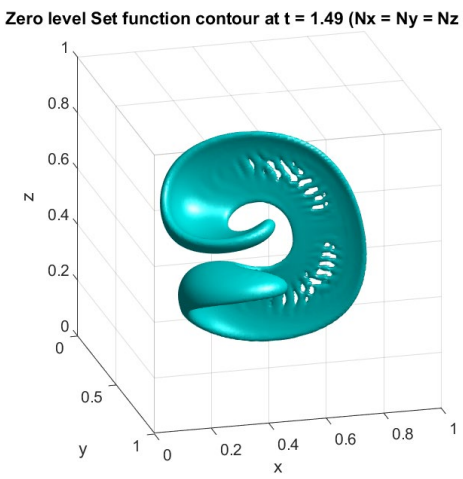
t = 0



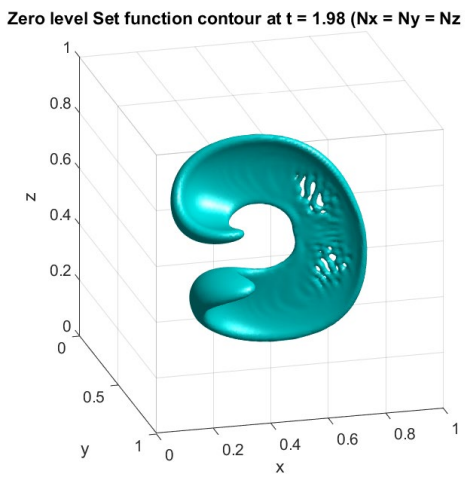
t = 0.48



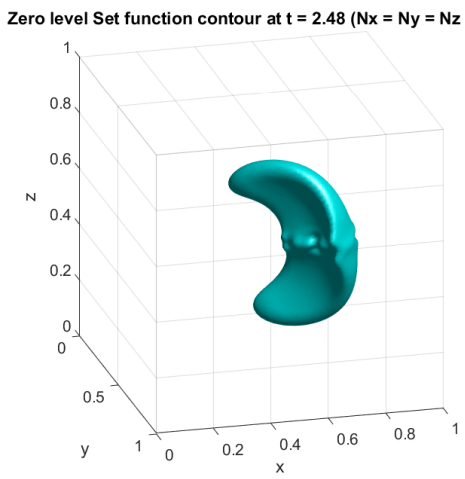
t = 0.98



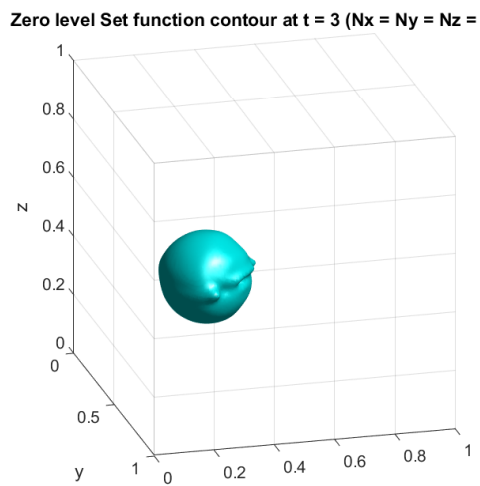
t = 1.49



t = 1.98



t = 2.48



t = 3 = T