Problem Defination

Consider a square cavity as shown in Figure 1 of side, a = 1 unit. The cavity is filled with a fluid which may be air. The top wall (lid) of the square cavity is moving with a velocity, u = 1 units/s, v = 0 units/s and all the other walls are stationary. Assume fluid is incompressible and flow is steady state and two-dimensional flow. Determine the fluid flow pattern and pressure distribution inside the cavity at Reynolds number, Re = 100 using any finite difference method you have learned from this AM5630 course (i.e. Stream function vorticity method, SMAC method).
Use the non-dimensional form of the Governing equations with appropriate boundary conditions. Solve this problem numerically and perform the post-processing tasks as follows:

1. Plot the u-velocity with y values graph at x=0.5 units.
2. Plot the v-velocity with x values at y=0.5 units.
3. Compare the x-y plots with Ghia et al. data (1982).

Use the grid size 51 * 51 along x-direction and y-direction initially. You can increase the grid till 101 * 101 to obtain the optimum grid by plotting x-y plots mentioned in points 1 and 2.

Reference:
Ghia, U., Ghia, K.N. and Shin, C.T. (1982) High-Re Solutions for Incompressible Flow Using the Navier-Stokes Equations and a Multigrid Method. Journal of Computational Physics, 48, 387-411.
http://dx.doi.org/10.1016/0021-9991(82)90058-4

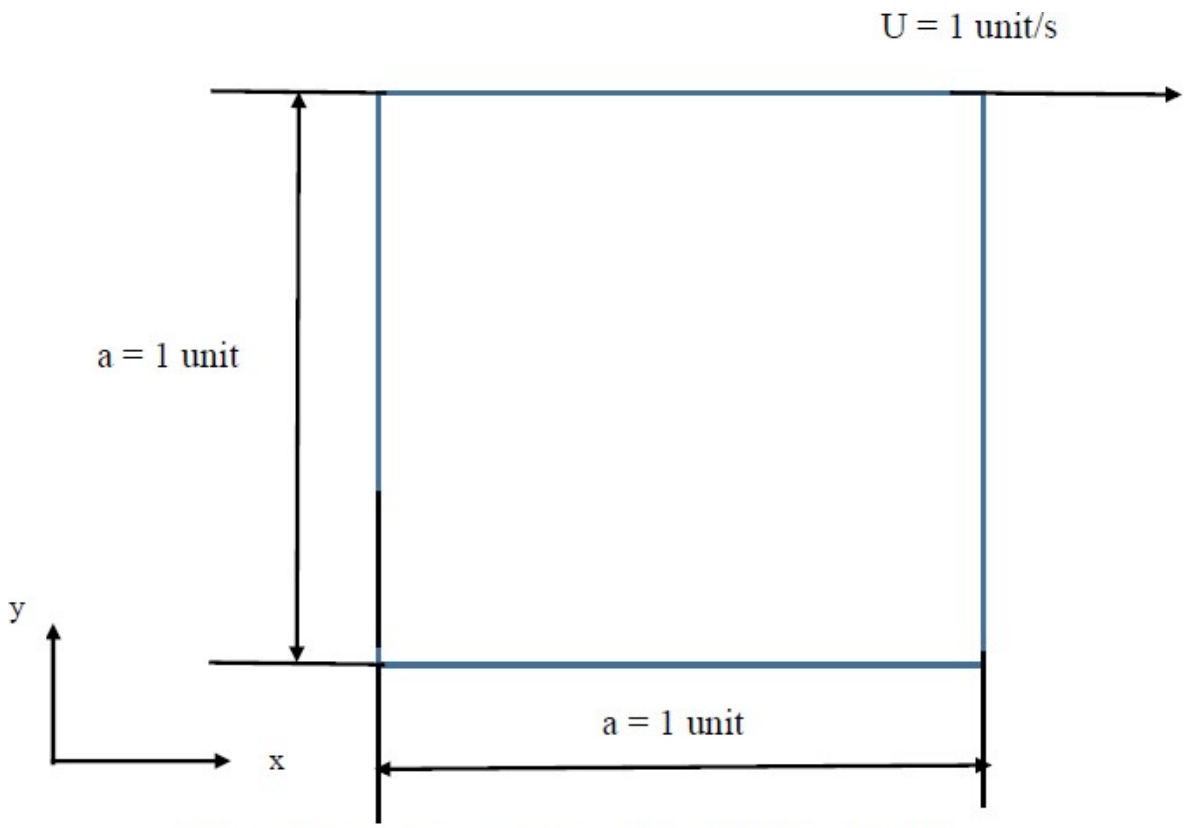
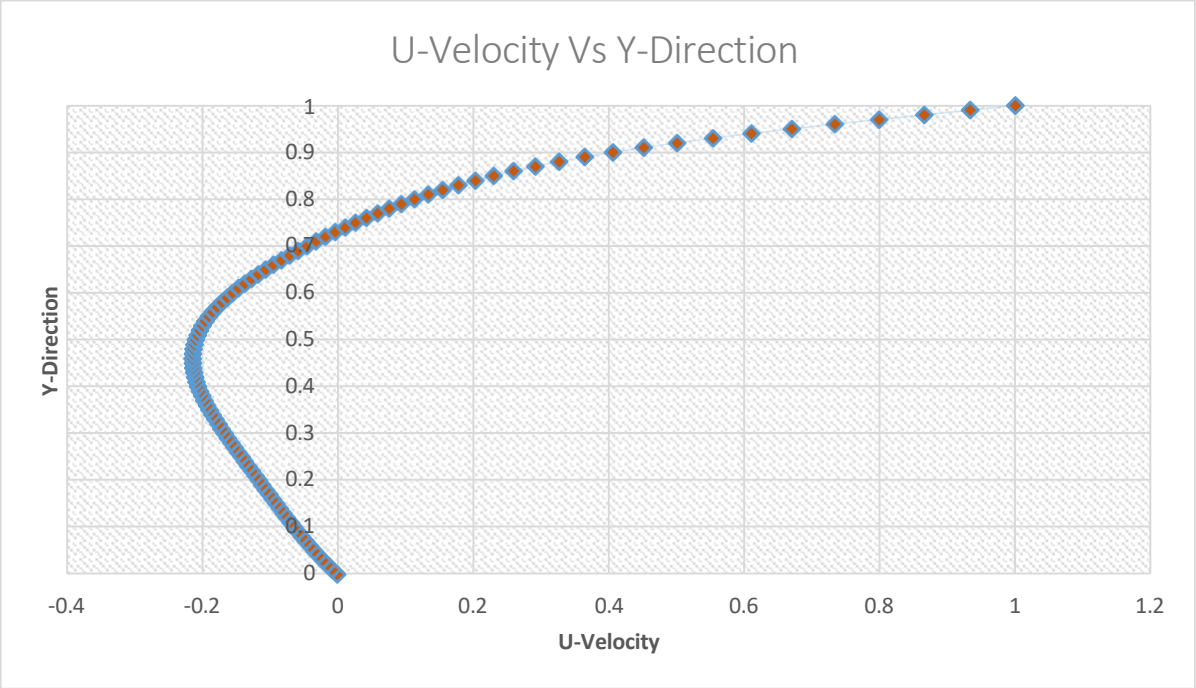
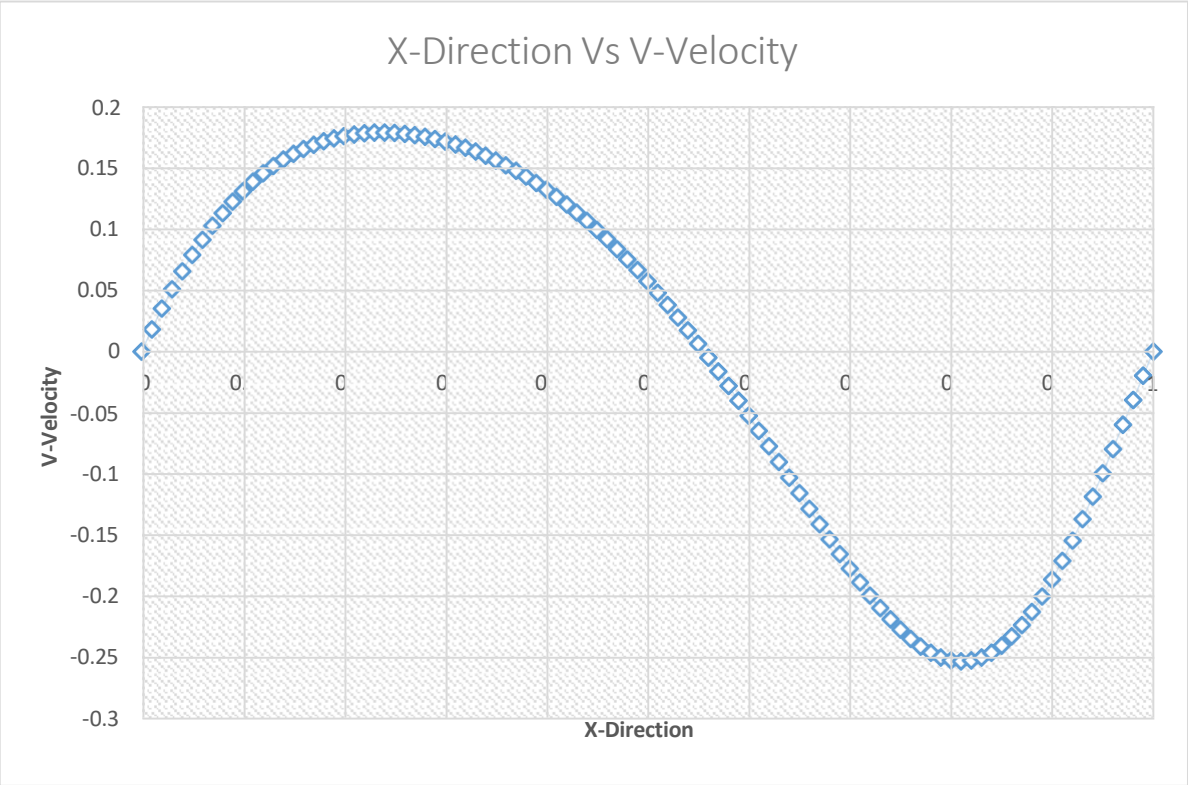


Figure 1: Computational domain of the **Lid Driven Cavity**

1. U-velocity with Y at X=0.5:- The graph for U-Velocity with Y at X=0.5 is given below-



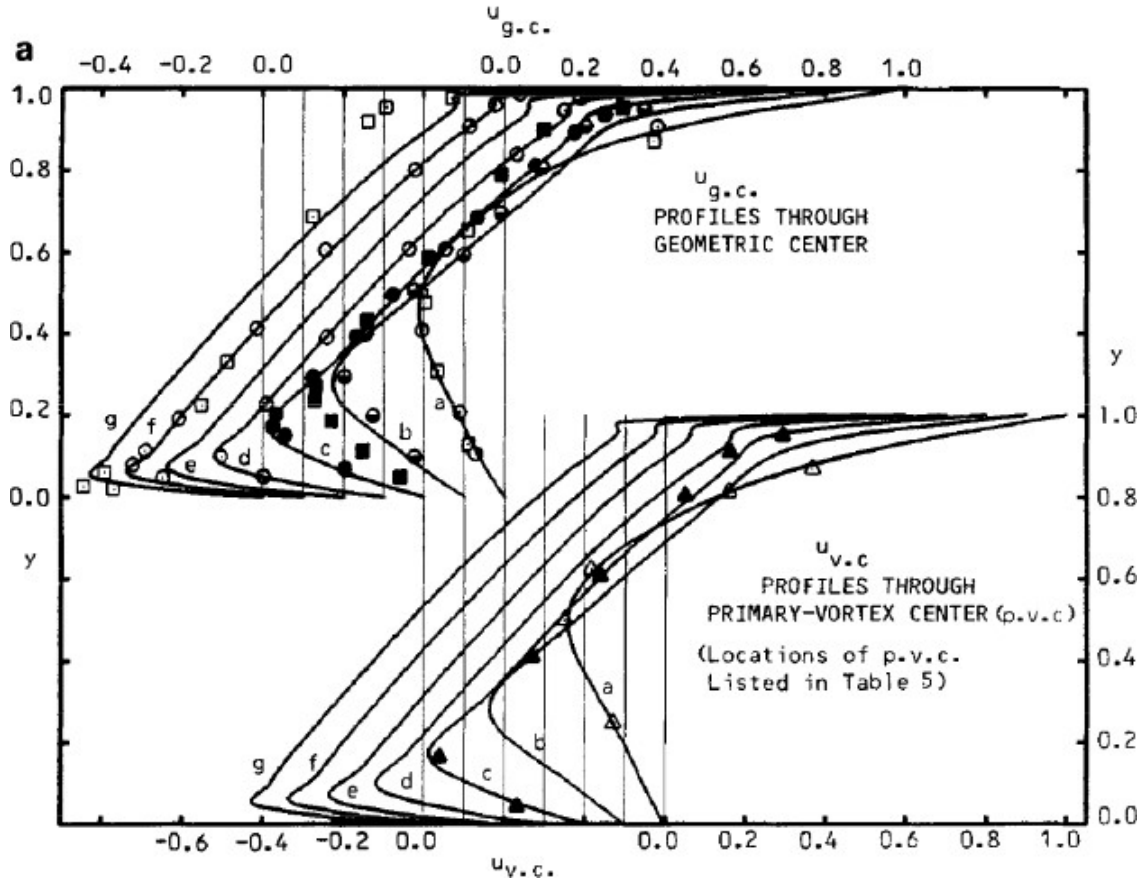
2. V-Velocity with X at Y=0.5:- The graph for V-Velocity with X at Y=0.5 is given below-



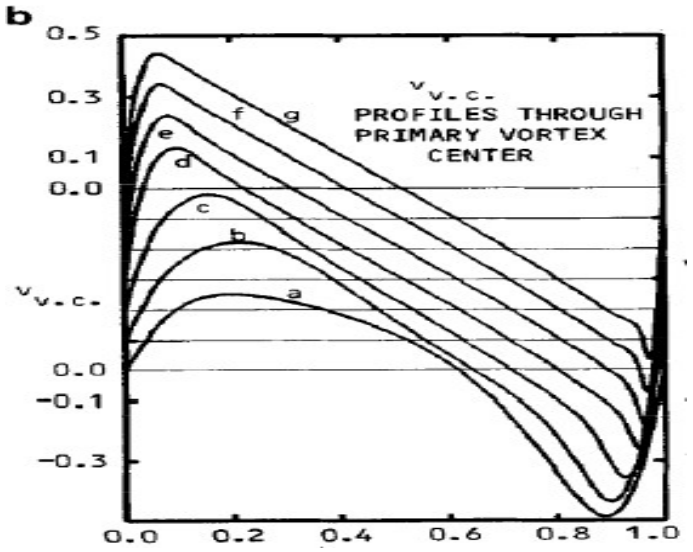
3. Compare the x-y plots with Ghia et al. data (1982):-

In this paper author has done the lid driven cavity experiment and shown the results. From the U-Velocity plot we can say that graph pattern is similar as ours.

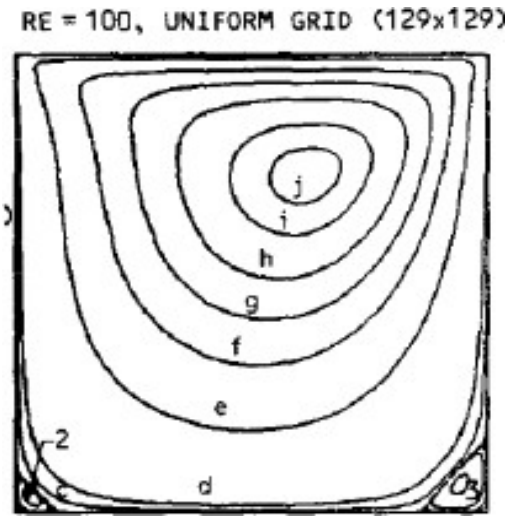
The U-velocity profile shown in the paper is-



The V- velocity profile is also similar to the profile I get through this code. The V-velocity profile shown in the paper is given below-



Also the streamline shown in the paper is similar to what I get through the code. The streamlines shown in the paper is given below-

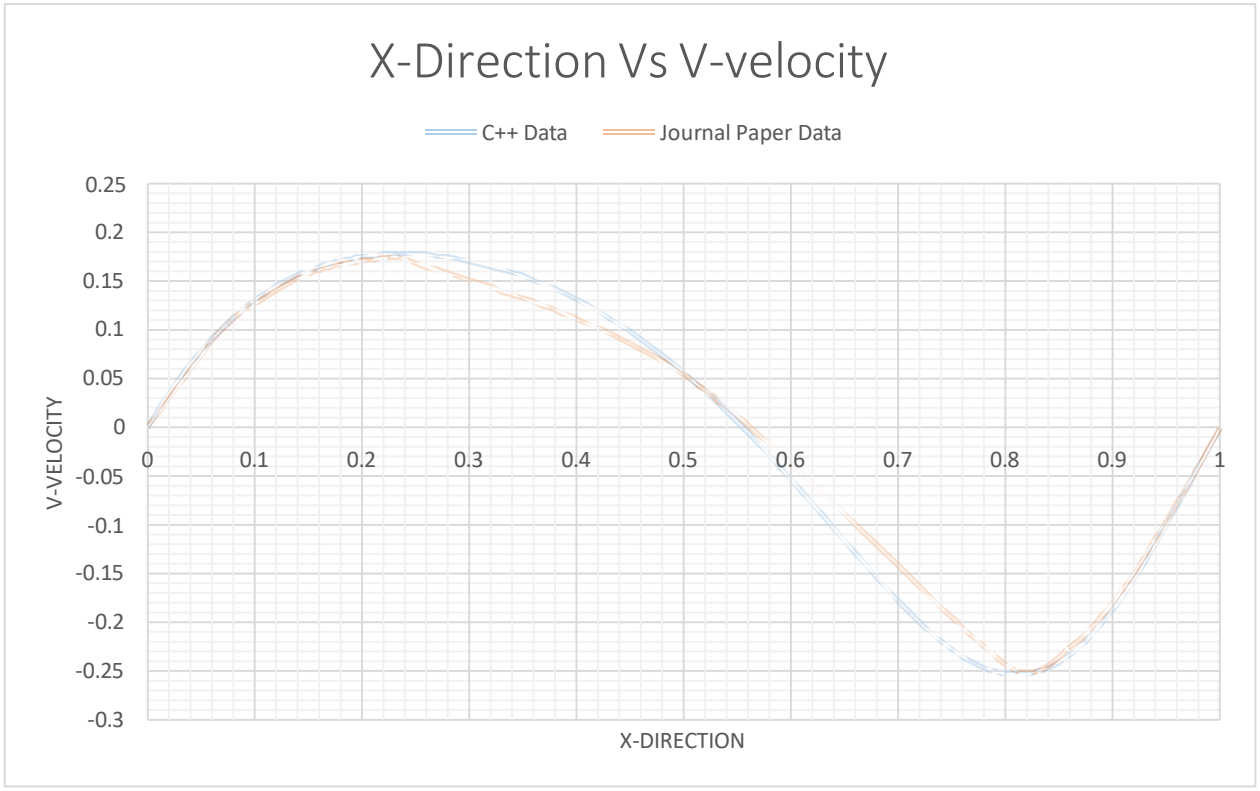


- Comparison of U-Velocity:- Now comparing the u-Velocities from journal paper with the u-Velocity values I have get through the code is also given below-

U-Velocity at x= 0.5	Y=0	Y=0.5	Y=1
From The paper	0	-0.21090	1
From The Code	0	-0.20836	1

So we can see that the U- velocity is close enough with the paper. As the paper use 129 grid point, and I have used 101 grid points, so there is no other similar point with my results.

A comparison plot is also given below-


X-Direction Vs V-velocity
C++ Data
Journal Paper Data
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
V-VELOCITY
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
X-DIRECTION