Project #1 **Computational Fluid Dynamics I** Prof. V. Esfahanian
Due Date: 28/2/97 TA: A.Bahrami & M.Fazli

Write a program and solve the (non-dimensional) Navier-Stocks equations in Stream function-Vorticity ($\psi - \omega$) formulation for the recirculating flow in the one of the following geometries, as discussed in the class. You are to solve with only SOR and SOR coupled with ADI methods. For convergence, set the tolerance for ψ and ω to be 10^{-5}. the specification for those double geometris are

- **Lid Driven Cavity** problem with Reynolds numbers 1 and 100.
- **Backward Step** problem with Reynolds numbers of 1, 100 and 500. At the inlet of duct the fully developed velocity boundary condition and at the walls, the no-slip boundary condition is considered. The flow leaves the channel in fully-developed conditions, too.

The requirments are as follows:

1. The surface vorticity (skin friction) on all sides of solid boundaries (to the same scale).
2. Plot the x-velocity and y-velocity profiles at $x/L = 0.5$ and $y/L = 0.5$ resepectively and validate your datas (only for Lid Driven Cavity).
3. Determine the reattachment length, x_r, for the Backward Step geometry and compare it for different Reynolds number.
4. Plot at least four representative contours of ψ and ω (including $\psi = 0$).
5. Compute the pressure in the domain. You need to set tha value of pressure somewheres at least in one point. You can choose the left bottom corner or the middle point of the bottom wall (for Lid Driven Cavity) or bottom corner of outlet (for Backward Step) and set $p = 1$ there.
6. Choose different values of relaxation factors for ψ and ω. Compare the SOR coupled with ADI and only SOR methods. Report your conclusions.
7. Prepare a report and explain your discretization and solution method including the flowchart of your program.

See the included figures on the next page to get more details on the geometries. You can solve only one of these geometries but who solve the both have 0.5 scores greater than others.

Attention: All plots must be drawn by Tecplot.

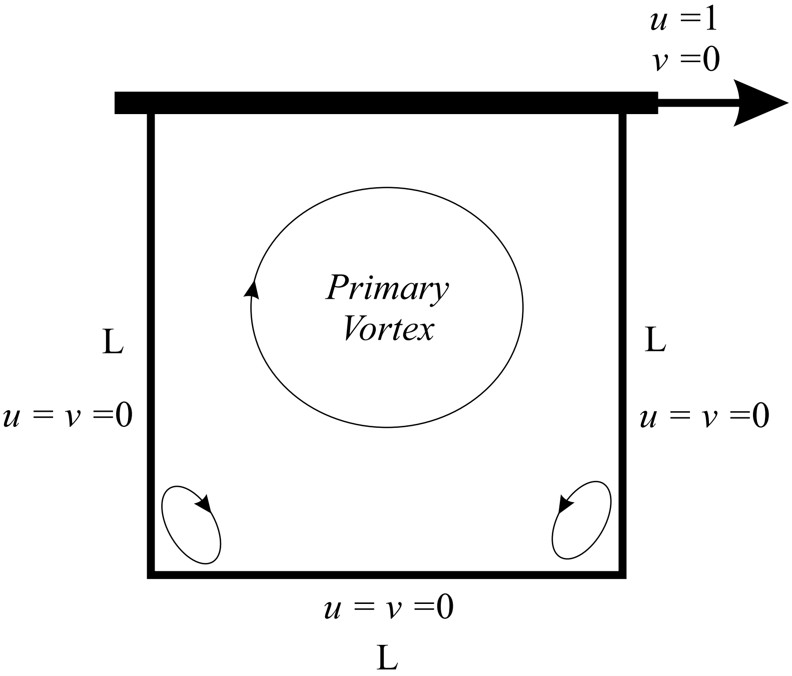

Figure 1: Lid Driven Cavity geometry and details

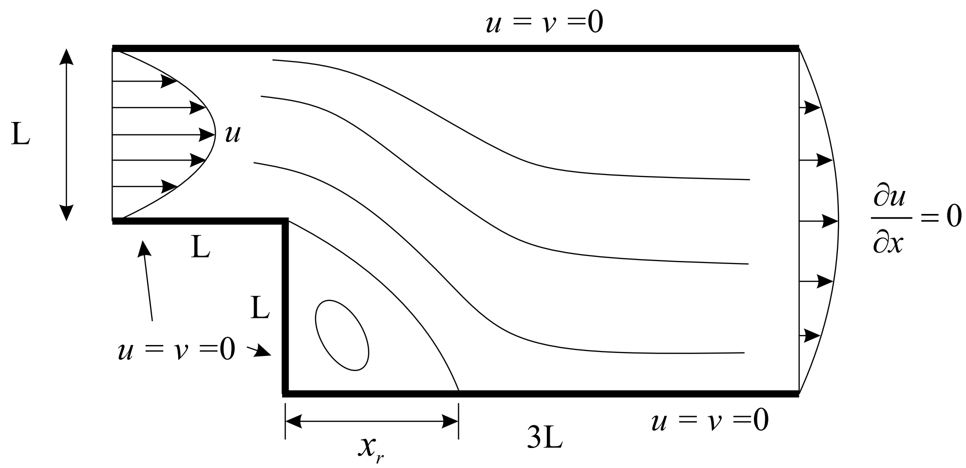

Figure 2: Backward Step geometry and details