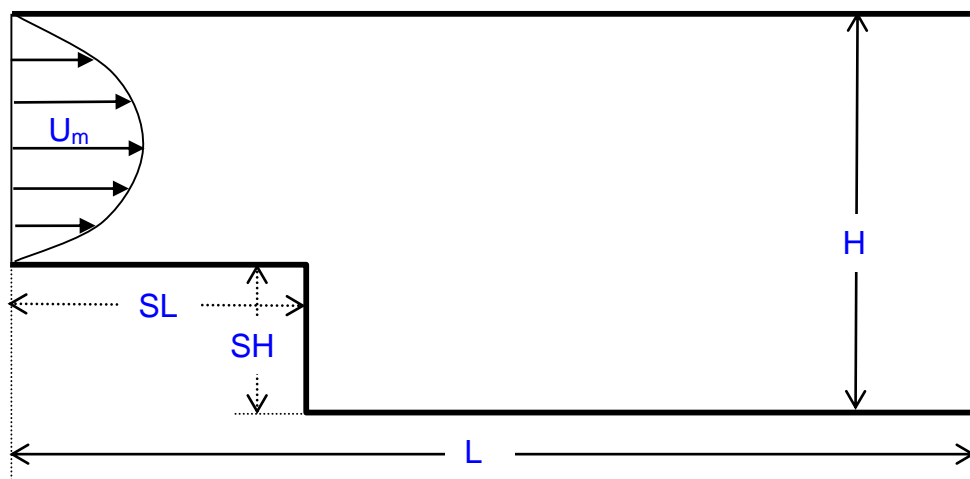


CE 580 COMPUTATIONAL TECHNIQUES FOR FLUID DYNAMICS

Homework - 9

Flow over Backward Facing Step

Consider flow over a backward facing step due to sudden enlargement of cross section. Flow at the inflow and outflow sections is uniform. Develop a computer program for numerical solution of the Navier-Stokes equations using u-v-p formulation. Assume 2D, steady, laminar flow.



1. Discretize the Navier-Stokes equations using finite volume method.
2. Define a staggered mesh system using constant Δx and Δy .
3. Define the boundary conditions for dependent variables involved in the solution and indicate their numerical implementation.
4. Describe the numerical solution methods for the governing equations.
5. Obtain an initial data for the dependent variables.
6. Discuss the stability conditions if required.
7. Define the condition of convergence.
8. Obtain the numerical solution for:

$$\begin{aligned} L &= 2.00 \text{ m}, & H &= 0.10 \text{ m}, & SL &= 0.40 \text{ m}, & SH &= 0.05 \text{ m}, \\ U_m &= 0.2, 1.0, 2.0 \text{ m/s}, & \nu &= 1 \times 10^{-4} \text{ m}^2/\text{s}, & \rho &= 1000 \text{ kg/m}^3 \end{aligned}$$

9. Make contour plots of streamlines for each case on the same page.
10. Make vector plot of velocity field for each case on the same page.
11. Compare the discharges at the inflow and outflow sections for each run and present them in a table.
12. Write a discussion on the results you obtained.