CFD Assignment 3 Lid Driven cavity flow -Due date: Monday, 7th January, 2019

1. The present task is to provide numerical solution of a steady flow within a square cavity, where the top lid is moving to the right at a constant velocity. The following figure shows a sample solution for Re=100 with central difference scheme. The Reynolds number is defined as $Re = \rho U_{lid} L / \mu$, where U_{lid} is the top lid velocity (1m/s) and L is the cavity height.
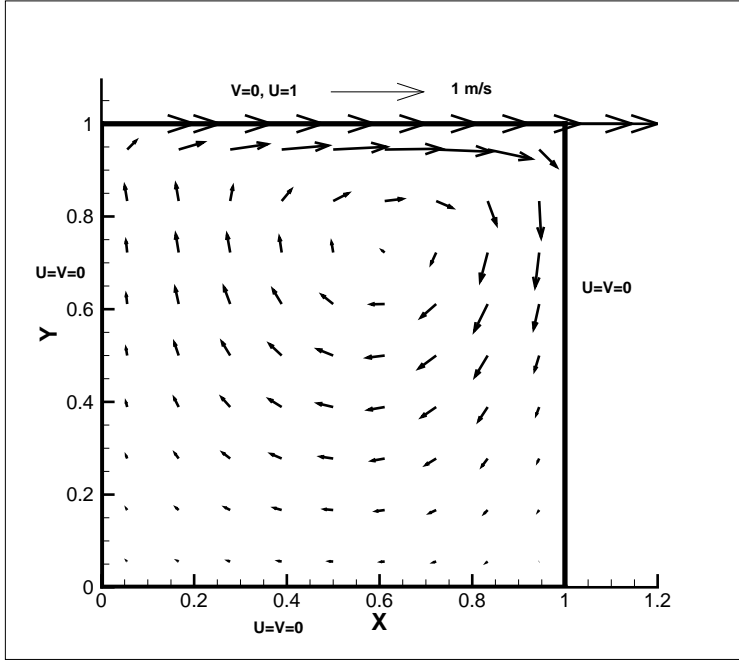
The flow field can be solved by the continuity and Navier-Stokes equations ($\rho = constant$):

$$\frac{\partial \rho U}{\partial x} + \frac{\partial \rho V}{\partial y} = 0$$

$$\frac{\partial \rho U}{\partial t} + \frac{\partial \rho UU}{\partial x} + \frac{\partial \rho VU}{\partial y} = -\frac{\partial P}{\partial x} + \mu \left[\frac{\partial^2 U}{\partial x^2} + \frac{\partial^2 U}{\partial y^2} \right]$$

$$\frac{\partial \rho V}{\partial t} + \frac{\partial \rho UV}{\partial x} + \frac{\partial \rho VV}{\partial y} = -\frac{\partial P}{\partial y} + \mu \left[\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} \right]$$

(a) Please compute the cavity flows with Reynolds number being 100, 1000 and 5000.

(b) Please use mesh size at least 81x81 and 161x161.

(c) Please also compare your results with the benchmark solutions from Gihia et al. (1982) for u(y) at x=0.5 and v(x) at y=0.5.

Ghia U, Ghia KN, Shin CT. High-Resolutions for incompressible flow using the NavierVStokes equations and a multigrid method. J Comput Phys 1982;48:387.

(d) Please compare the accuracy of the central difference, QUICK and MUSCL schemes.

2. Programming languages

(a) Please use programming language at your own choice.

(b) Please list your program in the report

(c) You can use artificial compressibility method, fractional step or SIMPLE method.

3. Please compile your results into a report. No hand written material should be included in the report. The report should be submitted through the turnitin website.

   The report should contain

   (a) Problem descriptions.

   (b) Introduction of methodology adopted

   (c) Results and discussions

   (d) Conclusion

   (e) List of programs