Computer Assignment 3B

Submitted by

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Tabulation of discretised algebraic equation	
Discretised Equation for Solving Stream Function	$\Psi_{i,j+1} + \Psi_{i,j-1} + \beta^2\Psi_{i+1,j} + \beta^2\Psi_{i-1,j} + (\Delta x)^2\omega_{i,j} = 2(1+\beta^2)\Psi_{i,j}$
Discretised Equation for U-V Update	$U = (\Psi i_{+1,j} - \Psi_{i-1,j})/\ (2\Delta y)$ $V = -\ (\Psi i,j_{-1} - \Psi_{i,j+1})/\ (2\Delta x)$
Discretised Equation for Vorticity BCs update	$\omega_{i,0} = \omega_{\ i,1}$ $\omega_{i,M-1} = \omega_{i,M-2}$ $\omega_{N-1,j} = -(2/\Delta y^2)\ (\Psi_{N-2,j} - \Psi_{N-1,j})$ $\omega_{0,j} = -(2/\Delta y^2)\ (\Psi_{1,j} - \Psi_{0,j}\ )$
Discretised Equation for Solving for Vorticity	$2(1+\beta^2)\ \omega_{i,j} = (1-\frac{Re^*\Delta x^*U_{i,j}}{2})\omega_{i,j+1} + (1+\frac{Re^*\Delta x^*U_{i,j}}{2})\omega_{i,j-1} + \beta^2(1-\frac{Re^*\Delta y^*V_{i,j}}{2})\omega_{i+1,j} + \beta^2(1+\frac{Re^*\Delta y^*V_{i,j}}{2})\omega_{i-1,j} + (\frac{(Ra/Pe)^*\Delta x}{2})(T_{i,j+1}-T_{i,j-1})$
Discretised Equation for Solving for Temperature	$2(1+\beta^2)\ T_{i,j} = (1-\frac{Pe^*\Delta x^*U_{i,j}}{2})T_{i,j+1} + (1+\frac{Pe^*\Delta x^*U_{ij}}{2})T_{i,j-1} + \beta^2(1-\frac{Pe^*\Delta y^*V_{i,j}}{2})T_{i+1,j} + \beta^2(1+\frac{Pe^*\Delta y^*V_{i,j}}{2})T_{i-1,j}$

Problem Definition

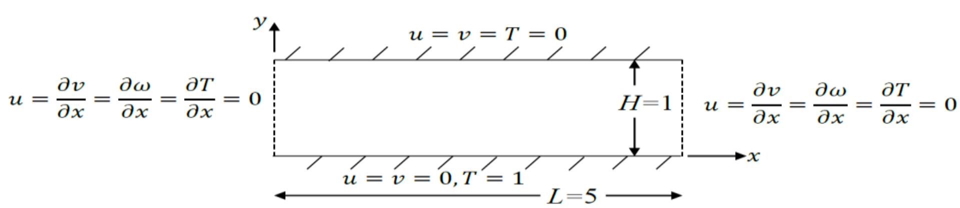
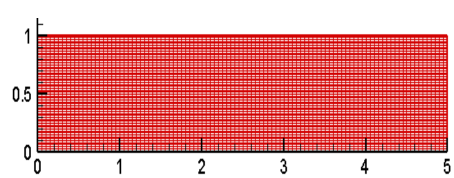


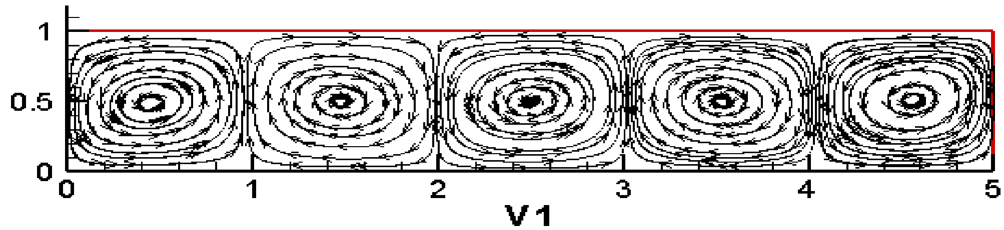
Figure: Flow inside a channel

Discretised Domain

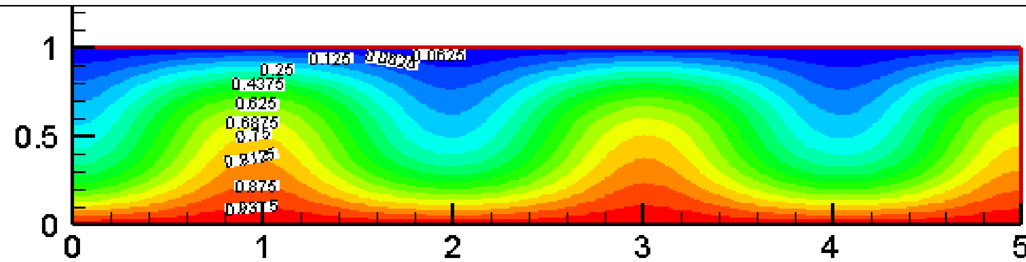


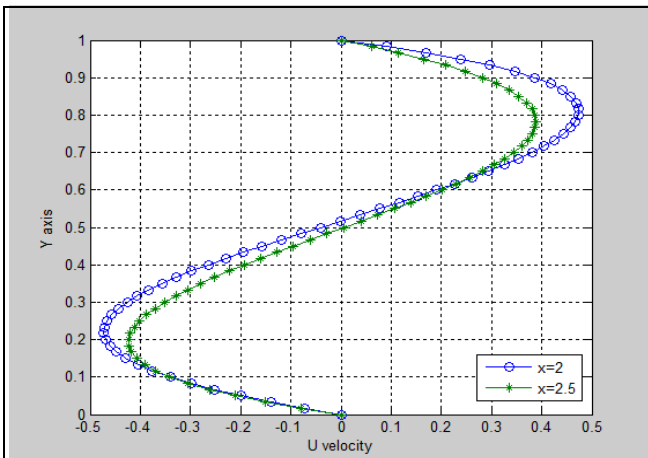
TABULATION OF RESULTS

Streamlines

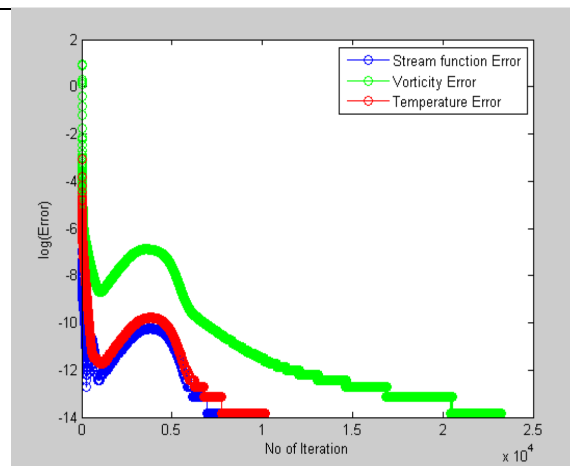


Temperature Contour





U velocity along Y axis at x=2 and 2.5

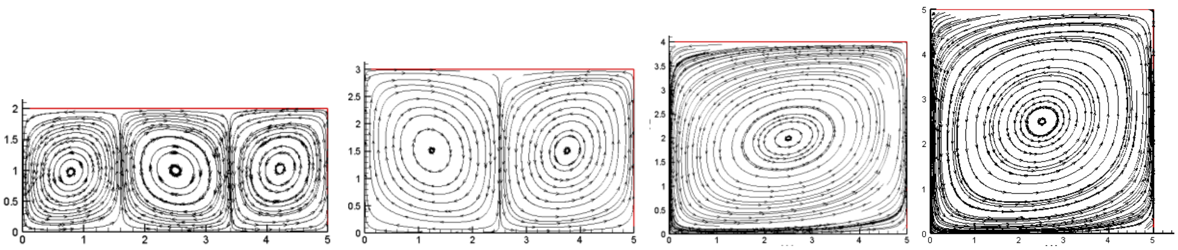


Convergence History

Discussion:

The code developed for this problem was tested for various Aspect Ratio (L: H) and it was found that number of convection cells formed is strong function of the aspect ratio.

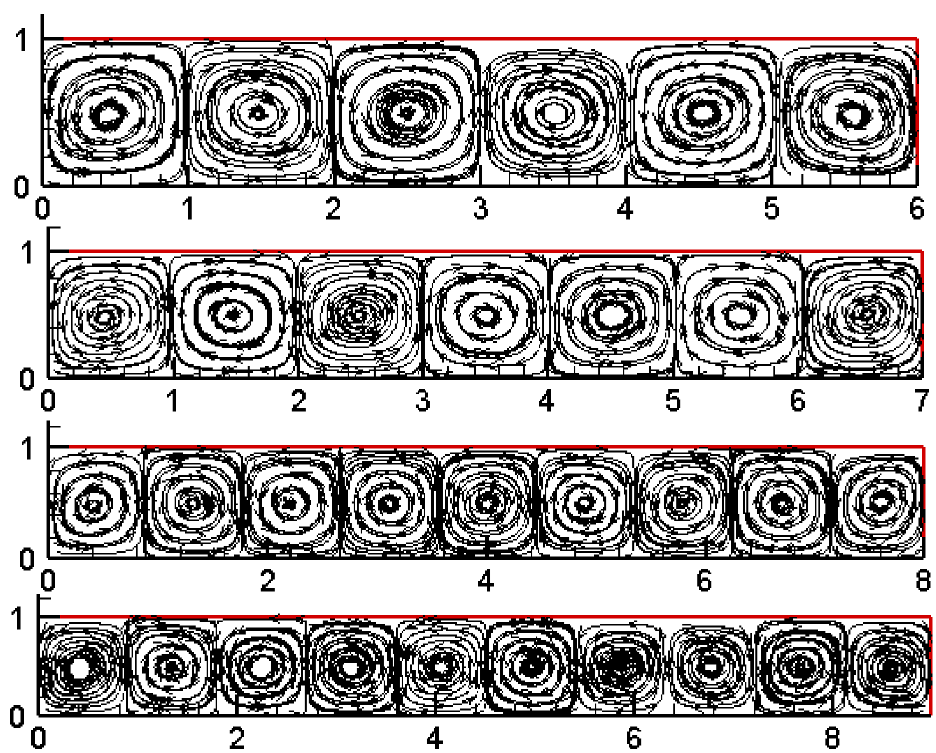
Keeping **L** (=5 units) constant



H=2 H=3 H=4 H=5

As we can see, the number of convection cells deceases as the aspect ratio approaches unity.

Keeping **H** (=1 units) constant



L=6

L=7

L=8

L=9

As we can see the number of convection cells increases as the L increases. Also the increase is proportional until L=8, after which the length scale of the convection cells changes and we get 10 convection cell for L=9.