ME 415: Computational Fluid Dynamics and Heat Transfer, Spring 2012
Assignment 4: Computation of the Fluid Flow (15% Weight)
Due Date: 12 April 2012

Notes:
1. Please provide: (i) the grid detail, (ii) the DE detail, (iii) the boundary condition implementation detail, (iv) a well documented code, (v) the required output (plots/any other such means).
2. Items (i), (ii), and (iii) above should be written out on a separate sheet and attached before items (iv) and (v).

Recall Problem 3 of Assignment 3. In addition to being thermally developing, now let the situation be hydrodynamically developing as well. Let a uniform flow with a velocity of 1 enter the channel purely in the axial direction. Use $\mu = 0.01$. For all other details, use the description from Problem 3 of Assignment 3.

1. Using the staggered grid and SIMPLE algorithm, solve for the velocity field in the domain specified for the channel. Use the Hybrid scheme for solving the momentum equations. Implement appropriate boundary conditions. For the iterative solutions use the scheme of your choice (point-by-point GS or line-by-line GS). Use the overall convergence criterion of 10^{-5} for the mass source.

2. Plot the axial velocity profiles at various axial locations to demonstrate the development of the velocity profile. The length of the channel may need to be adjusted to see fully developed parabolic velocity profile. Also plot the lateral velocity profile (y co-ordinate vs. magnitude of v) at the same axial locations.

3. After the velocity field is determined, re-solve Problem 3 of Assignment 3 to complete the solution of the hydrodynamically and thermally developing flow problem. Repeat the data analysis procedure, as outlined in Problem 3 of Assignment 3, and generate the Nusselt number data for this situation. Plot the Nusselt number data as a function of the axial distance.

4. Consult a Convection Heat Transfer book, and see if an analytical solution is available for the present problem of both hydrodynamically and thermally developing flow problem in a plane channel. If yes, superimpose the analytical solution, as appropriate.
