INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
DEPARTMENT OF MECHANICAL ENGINEERING
Guwahati – 781 039, Assam, India

ME 543 Computational Fluid Dynamics
Computer Assignment – 1
Due Date for Submission: 26.08.15 (Wednesday), <u>No Late Submission</u>

Solve the following partial differential equation using below said iterative schemes with specified boundary conditions for **100×100** grid size as shown in the figure.

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0 \qquad\qquad \epsilon = \sqrt{\frac{\sum_{\substack{i=2,M-1 \\ j=2,N-1}} (T^{k+1} - T^k)^2}{(M-2) \times (N-2)}}$$

1. Point Gauss-Seidel iterative method
2. Point Successive Over Relaxation (PSOR) method
3. Line Gauss-Seidel iterative method (TriDiagonal Matrix Algorithm)
4. Alternating Direction Implicit method (ADI)

Discretize the PDE using finite difference method with uniform grid $M \times N$. Write the code such a way so that you can input the values of $N, M, \Delta x, \Delta y$. Here $\Delta x, \Delta y$ may be different, so use $= \frac{\Delta x}{\Delta y}$.

Submit the hard copy of the results in terms of temperature contours, and report on discretized algebraic equation of each iterative method, comparison study of number of iterations and time taken to converge up to $\epsilon < 10^{-6}$. Plot ω vs number of iterations for PSOR method and find ω_{opt} from the plot. Email only the soft copy of the code.

The exact solution of the problem is given below to validate your results.

$$T(x,y) = T_c + (T_h - T_c)\left[1 - 2\sum_{n=1}^{\infty} \frac{1-(-1)^n}{n\pi} \frac{\sinh\left(\frac{n\pi y}{L}\right)}{\sinh\left(\frac{n\pi H}{L}\right)} \sin\left(\frac{n\pi x}{L}\right)\right]$$