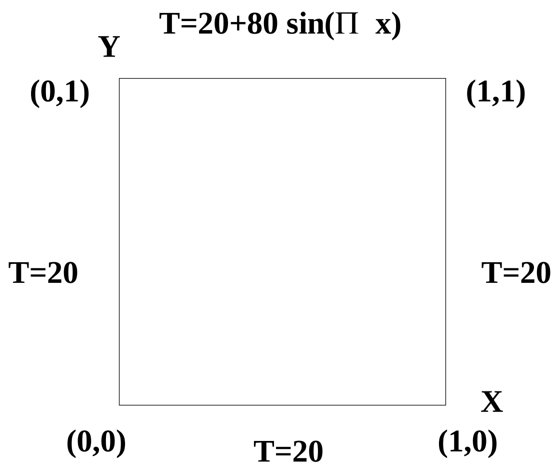
CFD Assignment 1 Conduction -Due date: Monday, 26th October, 2020

1. The present task is to provide numerical solution of a steady conduction problem and compare the predicted results with analytic solutions. For a two dimensional conduction equation,

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0$$

   the boundary conditions are, shown in Figure. The analytic solution of the problem is



$$T = 20 + 80 sin(\pi x)\frac{sinh(\pi y)}{sinh(\pi)}$$

   (a) indicate also how you solve the linear set of equations, i.e. Gauss Seidel ....
   (b) the mesh sizes are set to be 11x11, 21x21, 41x41, and 81x81
   (c) compare the predicted and analytic results at y=0.5 and comment on your results.
   (d) Show the order of accuracy of the scheme for the second, fourth order schemes and the nine points formula

2. Programming languages
   (a) Please use programming language at your own choice.
   (b) Please list your program in the report

3. **Please compile your results into a report using word processing software. No hand writing report is permitted.**

4. **The report must be submitted to cfd class account at turnitin. No other submission is possible.**

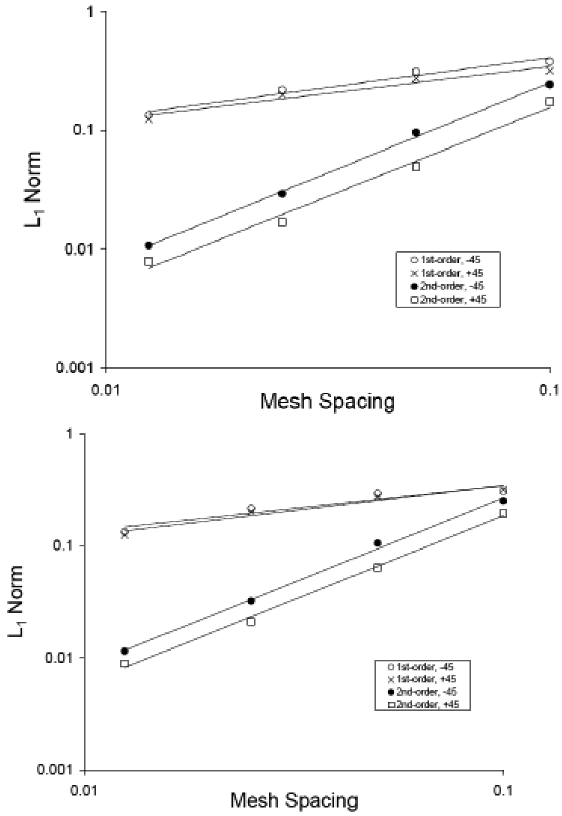


Figure 7. ***L_1*** **norm of the error without (top) and with (bottom) averaging, simplified gradient reconstruction and 1-D-type *minmod* limiter, for the case $a_x = a_y = 1$. Lines are least square fits.**

Figure 1: Accuracy example

5. The report should contain

    (a) Problem descriptions.

    (b) Introduction of methodology adopted

    (c) Results and discussions

    (d) Conclusion

    (e) List of programs

Fourth order forward difference

$$f''(x_1) = \frac{1}{12h^2}[10f(x_0) - 15f(x_1) - 4f(x_2) + 14f(x_3) - 6f(x_4) + f(x_5)]$$

$$f''(x_{m-1}) = \frac{1}{12h^2}[10f(x_m) - 15f(x_{m-1}) - 4f(x_{m-2}) + 14f(x_{m-3}) - 6f(x_{m-4}) + f(x_{m-5})]$$

Nine points formula for Laplacian:

$$\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0$$

$$\frac{1}{6h^2}[4(f(i+1,j) + f(i-1,j) + f(i,j+1) + f(i,j-1))$$
$$+f(i+1,j+1) + f(i+1,j-1) + f(i-1,j+1) + f(i-1,j-1) - 20f(i,j)] = 0$$