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

ME 543 Computational Fluid Dynamics
Computer Assignment – 3 Part B

Due Date for Submission: 18.10.15 (Sunday), <u>No Late Submission</u>

Solve the following partial differential equation using the finite difference method with the specified boundary conditions for the geometry with **101×61** grid size as shown in the figure.

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}=-\omega$$

$$u\frac{\partial\omega}{\partial x}+v\frac{\partial\omega}{\partial y}=\frac{1}{\mathrm{Re}}\left(\frac{\partial^2\omega}{\partial x^2}+\frac{\partial^2\omega}{\partial y^2}\right)+\frac{Ra}{Re\,Pe}\frac{\partial T}{\partial x}$$

$$u=\frac{\partial\psi}{\partial y}\ ,\quad v=-\frac{\partial\psi}{\partial x}$$

$$u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}=\frac{1}{\mathrm{Pe}}\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}\right)$$

$$Re=\frac{u_oH}{\nu},\quad Pr=\frac{\nu}{k},\ \ Pe=Re\,Pr,\qquad Ra=\frac{\beta g\Delta T H^3}{\nu\alpha}$$

Apply the finite difference discretization to replace all derivatives with the corresponding central difference expressions with uniform grid $M\times N$ and *write the discretized equations of the governing equations and boundary conditions of stream function & vorticity in the **report***. Write the code in such a way so that you can input the values of Re, N, M, H, L. Submit the hard copy of the results and discussion for **Re=18.1, Pr=0.71, Ra=2472** in terms of streamlines, velocity vectors, u and v velocity profile at locations x=2 and, 2.5 (in same x-y plot). **Email** only the soft copy of the code.

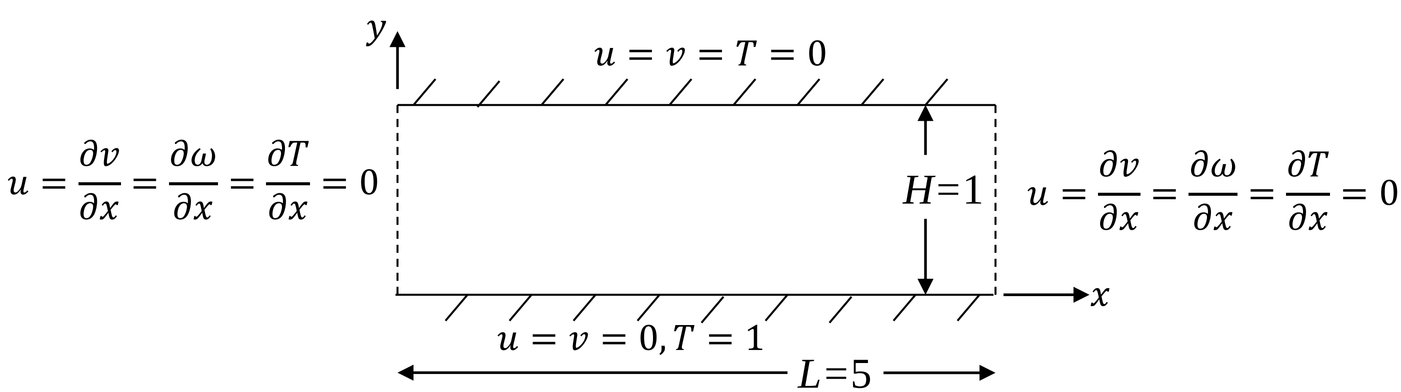

Figure: Flow inside a channel

Reference: K-C. Chiu, J. Ouazzani, and F. Rosenberger, "Mixed convection between horizontal plates – II. Fully developed flow", International Journal of Heat and Mass Transfer, Vol. 30, No. 8, pp. 1655-1662, 1987.