

Computational Fluid Dynamics (AE/ME 339)
MAE Dept.

Home Work Problem

This problem involves free convection flow at a heated vertical wall and the numerical solution of the simplified non-dimensionalized equations. Use the explicit method as discussed in class.

Solve for the dependent variables U_{bar} , V_{bar} , and θ . Use the initial and boundary conditions are follows:

$\tau = 0$:

$$U_{\text{bar}} = V_{\text{bar}} = 0, \theta = 0.$$

$\tau > 0$:

$$\xi = 0: \quad U_{\text{bar}} = V_{\text{bar}} = 0, \theta = 0. \text{ (bottom wall)}$$

$$\eta = 0: \quad U_{\text{bar}} = V_{\text{bar}} = 0, \theta = 1. \text{ (vertical wall)}$$

$$\eta = \text{infinity}: \quad U_{\text{bar}} = 0, \theta = 0.$$

Use the following for dimensional calculations: $T_w = 50 \text{ C}$, and $T_{\text{infty}} = 20 \text{ C}$.

Assume that the coefficient of thermal expansion is constant and is given by the following expression.

$$\beta = \frac{1}{\left(\frac{T_w + T_{\infty}}{2} + 273\right)} \dots (1/K)$$

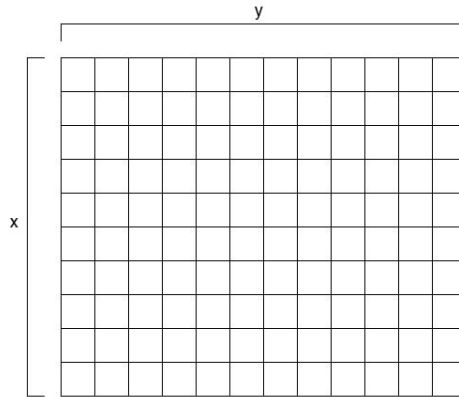
The time step must satisfy the approximate stability criterion given below.

$$\frac{\Delta \tau}{(\Delta \eta)^2} \leq \frac{1}{2}$$

For the finite domain for your calculation choose $\xi_{\text{max}} = 100$, and $\eta_{\text{max}} = 25$.

Use $\Delta \xi = 10$, $\Delta \eta = 2.5$ and $\Delta \tau = 0.5$.

1. Prepare a detailed flow diagram of the calculations that you will be doing.
2. Calculate the variables at $\tau = 80$. Show the result in tabular form as indicated in the figure given below. Plot the distributions of the dimensional velocities and temperature along a horizontal line where ($\xi = \xi_{\text{max}}/2.0$).
3. Write a short note describing the procedure, details of the calculations and discussion of the results. Attach a listing of your computer program.



Make 3 tables for U, V, and theta values for the nodes
Choose print interval such that you show only 10 values
in each directions at equally spaced nodes.