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

<u>Home Work Problem</u>

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_bar = V_bar = 0, $\theta = 0$.

$\tau > 0$:
$\xi = 0$: U_bar = V_bar = 0, $\theta = 0$. (bottom wall)
$\eta = 0$: U_bar = V_bar = 0, $\theta = 1$. (vertical wall)
η = infinity: U_bar = 0, $\theta = 0$.

Use the following for dimensional calculations: Tw = 50 C, and T_infty = 20 C.
Assume that the coefficient of thermal expansion is constant and is given by the following expression.

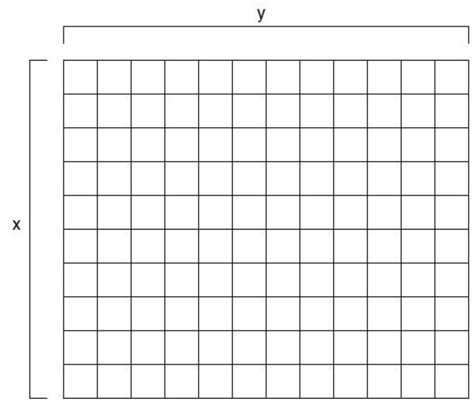
$$\beta = \frac{1}{\left(\frac{T_w + T_\infty}{2} + 273\right)} .....(1/K)$$

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

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

For the finite domain for your calculation choose ξ_max = 100, and η-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 <u>dimensional</u> velocities and temperature along a horizontal line where (ξ = ξ_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.