

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

Home Work Problem 7

Transform the simplified equations (Eqs. 1, 5 and 6, topic11 slides) of free convection flow into non-dimensional form using the following non-dimensionalization scheme.

Assume $\alpha = \nu$.

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \dots \dots \dots (1)$$

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} = g_x \beta (T - T_\infty) + \nu \frac{\partial^2 u}{\partial y^2} \dots \dots \dots (5)$$

$$\frac{\partial T}{\partial t} + u \frac{\partial T}{\partial x} + v \frac{\partial T}{\partial y} = \alpha \frac{\partial^2 T}{\partial y^2} \dots \dots \dots (6)$$

$$\xi = x (g \beta \Delta T / \nu^2)^{\frac{1}{3}}$$

$$\eta = y (g \beta \Delta T / \nu^2)^{\frac{1}{3}}$$

$$\tau = t (g \beta \Delta T)^{\frac{2}{3}} / \nu^{\frac{1}{3}}$$

$$\bar{u} = u / (\nu g \beta \Delta T)^{\frac{1}{3}}$$

$$\bar{v} = v / (\nu g \beta \Delta T)^{\frac{1}{3}}$$

$$\theta = \frac{T - T_\infty}{T_1 - T_\infty} = \frac{T - T_\infty}{\Delta T}$$