JME 3700
February 9, 2012

Homework #4

1. (10 pts) The steady–state two–dimensional velocity field for a flow is given by

$$\mathbf{V} \;=\; (y+2)\,\hat{\imath} \;+\; 2\,\hat{\jmath}\,.$$

Determine the equation in the (x, y) plane describing the specific streamline that passes through the origin, $(0, 0)$. It may be more convenient to write your answer in the form $x = x(y)$ rather than in the conventional way of $y = y(x)$.

2. (10 pts) We have a velocity field whose form is $\mathbf{V} = u\,(x, y)\,\hat{\imath} + v\,(x, y)\,\hat{\jmath}$, where $u\,(x, y) = C\,x^2$ and $v\,(x, y) = C\,y^2$ and where $C \neq 0$ is a constant. Determine the two components of the acceleration, a_x and a_y, and any point(s) where the acceleration vanishes.

3. (10 pts) The steady–state two–dimensional velocity field for a flow is given by

$$\mathbf{V} \;=\; u\,(x, y)\,\hat{\imath} \;+\; v\,(x, y)\,\hat{\jmath}\,,$$

where $u\,(x, y) = x^2$ and $v\,(x, y) = -y$. Show that streamlines are given by the family of curves $e^{1/x}/y = C$, where C is a constant.

4. (10 pts) The temperature distribution in a certain fluid is $T = C_0 t + C_1 x + C_2 y$, where C_0, C_1, and C_2 are constants. Find the expression for the time rate of change of temperature for a fluid particle whose velocity is $\mathbf{V} \;=\; C_1 y\,\hat{\imath} \;+\; C_2 x\,\hat{\jmath}$.

5. (10 pts) In a certain case, the steady–state two–dimensional velocity field is given by

$$\mathbf{V} \;=\; u\,(x, y)\,\hat{\imath} \;+\; v\,(x, y)\,\hat{\jmath}\,,$$

where $u\,(x, y) = x - y$ and $v\,(x, y) = xy^2 - 27$. Find the location of any stagnation points, i.e. points where the velocity vanishes.